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LIST OF PAPERS.

Page

AITCHISON, JAMES EDWARD T., F.L.S., Surgeon-Major H.M. Bengal Army.

On the Flora of the Kuram Valley, &c., Afghanistan.—Part II. (Map and Plates I.–XXX., and a woodcut.) 139

BAKER, JOHN GILBERT, F.R.S., F.L.S., Royal Gardens, Kew.

On a Collection of Ferns made by the Rev. R. B. Comins in the Solomon Islands 293

BENTHAM, GEORGE, F.R.S., F.L.S.

Notes on Gramineæ 14

BOLUS, HARRY, F.L.S.

Notes on some Cape Orchids. (With 4 woodcuts.).......... 233

A List of published Species of Cape Orchideæ 335

CLARKE, CHARLES BARON, M.A., F.R.S., F.L.S.

On a Hampshire *Orchis* not represented in 'English Botany.' (Plate XXXI.) 206

Note on two Himalayan Ferns erroneously treated in the "Ferns of Northern India" 289

DARWIN, CHARLES, LL.D., F.R.S., F.L.S.

The Action of Carbonate of Ammonia on the Roots of certain Plants. (With 2 woodcuts.) 239

The Action of Carbonate of Ammonia on Chlorophyll-bodies. (With 3 woodcuts.) 262

DARWIN, FRANCIS, M.B., F.L.S.

On the Connection between Geotropism and Growth 218

DICKIE, Dr. GEORGE, F.R.S., F.L.S., ex-Professor of Botany, University of Aberdeen.

Notes on Algæ from the Himalayas 230

Page

FICALHO, Prof. Count, and W. P. HIERN, M.A., F.L.S.
On Central-African Plants collected by Major Serpa Pinto. (Abstract.) 13

FORBES, H. O.
On two new, and one wrongly referred, Cyrtandreæ 297

HENSLOW, Rev. GEORGE, M.A., F.L.S., F.G.S.
Note on a Proliferous Mignonette. (Plate XXXII.) 214
Note on Staminiferous Corollas of *Digitalis purpurea* and *Solanum tuberosum*. (Plate XXXIII.) 216

HIERN, WILLIAM PHILIP, M.A., F.L.S., and Prof. Count FICALHO.
On Central-African Plants collected by Major Serpa Pinto. (Abstract.) 13

HOOKER, Sir J. D., F.R.S., Vice-President Linn. Soc.
On *Dyera*, a new Genus of Rubber-producing Plants belonging to the Natural Order Apocynaceæ, from the Malayan Archipelago 291

JACKSON, B. DAYDON, Secretary Linn. Soc.
Note on *Hibiscus palustris*, Linn., and certain allied Species .. 9
Note on Negative Heliotropism in *Fumaria corymbosa*, Desf. .. 232
On the Occurrence of Single Florets on the Rootstock of *Catananche lutea*. (With a woodcut.) 288

KIRK, THOMAS, F.L.S.
Notes on Recent Additions to the New-Zealand Flora 285

LYNCH, R. IRWIN, A.L.S., Curator of the Botanic Garden, Cambridge.
On a Contrivance for Cross-fertilization in *Roscoea purpurea*; with incidental reference to the Structure of *Salvia Grahami*. (With a woodcut.) 204

McNAB, W. R., M.D., F.L.S., Professor of Botany Roy. Coll. of Science, Dublin, and Scientific Superintendent of the Royal Botanic Garden, Glasnevin.
Report on the Arctic Drift Woods collected by Capt. Feilden and Mr. Hart in 1875 and 1876. (With a woodcut.) 135
Note on *Abies Pattonii*, Jeffrey MSS., 1851 208

MARSHALL-WARD. See WARD, H. MARSHALL.

MASTERS, MAXWELL T., M.D., F.R.S., F.L.S.
Note on the Foliation and Ramification of *Buddleia auriculata*. 201
On a new Species of *Gossypium* from East Tropical Africa 212

Page

MAW, GEORGE, F.L.S., F.G.S.

Notes on the Life-history of a Crocus, and the Classification and Geographical Distribution of the Genus. (Plates XXXIV. & XXXV. and 6 woodcuts.) 348

SHATTOCK, SAMUEL G.

On the Reparative Processes which occur in Vegetable Tissues. (With 2 woodcuts.) 1

SORBY, HENRY C., LL.D., F.R.S., F.L.S., Vice-Pres. Geol. Soc.

On the Green Colour of the Hair of Sloths. (Abstract.) 8

WARD, H. MARSHALL, B.A., Fellow of Owens College, Manchester, late on special duty as Cryptogamist to the Government of Ceylon.

Researches on the Life-history of *Hemileia vastatrix*, the Fungus of the "Coffee-leaf Disease" 299

EXPLANATION OF THE PLATES.

PLATE

I. MAP to illustrate the Flora of the Kuram Valley, Afghanistan.

II. CLEMATIS ROBERTSIANA.
III. OXYGRAPHIS SCHAFTOANA.
IV. CORYDALIS PULCHELLA.
V. ASTRAGALUS KURAMENSIS.
VI. ONOBRYCHIS DASYCEPHALA.
VII. ROSA BEGGERIANA.
VIII. ROSA ECÆ.
IX. GENTIANA MICRANTHA and SAXIFRAGA AFGHANICA.
X. COTYLEDON TENUICAULIS and SEDUM PACHYCLADOS.
XI. PIMPINELLA TRIPARTITA.
XII. PLEUROSPERMUM PULCHRUM.
XIII. ANGELICA STRATTONIANA.
XIV. AITCHISONIA ROSEA.
XV. SCABIOSA (§ PTEROCEPHALUS) AFGHANICA.
XVI. ASTER LACUNARUM.
XVII. COUSINIA CARTHAMOIDES.
XVIII. COUSINIA ELEGANS.
XIX. PERTYA AITCHISONI.
XX. RHODODENDRON COLLETTIANUM.
XXI. RHODODENDRON AFGHANICUM.
XXII. ACANTHOLIMON CALOCEPHALUM.
XXIII. STATICE GRIFFITHII.
XXIV. ARNEBIA SPECIOSA.
XXV. VERONICA RUPESTRIS.
XXVI. NANNORRHOPS RITCHIEANA.
XXVII. EREMURUS AITCHISONI.
XXVIII. CAREX FISSIROSTRIS.
XXIX. AGROSTIS SUBARISTATA.
XXX. AVENA OLIGOSTACHYA.

(Plates II–XXX:) Plants and details in illustration of Dr. Aitchison's paper "On the Flora of the Kuram Valley, Afghanistan."

XXXI. ORCHIS INCARNATA, Linn., illustrating Mr. C. B. Clarke's paper.

XXXII. PROLIFEROUS MIGNONETTE.
XXXIII. STAMINIFEROUS *Digitalis purpurea*.

(Plates XXXII–XXXIII:) Teratological illustrations to the Rev. G. Henslow's papers.

XXXIV. CORM-REPRODUCTION in *Crocus*.
XXXV. DISSECTIONS of SPATHES of *Crocus*.

(Plates XXXIV–XXXV:) Diagrams referring to Mr. Maw's memoir.

ERRATUM.

Page 31, line 19 from top, the final **æ** has fallen out, therefore read **Bambuseæ.**

THE JOURNAL

OF

THE LINNEAN SOCIETY.

On the Reparative Processes which occur in Vegetable Tissues. By SAMUEL G. SHATTOCK. (Communicated by Prof. MICHAEL FOSTER, F.R.S., F.L.S.)

[Read March 3, 1881.]

IT may be right to state that the following observations were made without any knowledge that investigations of a similar kind had been in progress at the hands of others. Quite recently (September 1880) the work of Dr. Frank, 'Die Krankheiten der Pflanzen,' has been published; and this, amongst other subjects, contains an article on Repair. And to these observations I will refer, as occasion arises, in confirmation of, or as supplementary to, what is here recorded.*

I may pass over the effects which ensue after the amputation of parts in the simpler forms of vegetable tissues, as in septate Algæ, or those organisms (as *Ulva*) in which the component

* Sir James Paget has also referred to some of these in his address on Elemental Pathology, delivered at the Pathological Section of the British Medical Association, 1880.

cells are so arranged as to form a compact leaf-like parenchyma. The repair in all such simple cellular or parenchymatous plants, with perhaps very rare exceptions, is effected by disintegration of the cells spoiled and the unmodified growth of the parts immediately beneath. Frank* quotes from Hanstein a proper cell-repair as occurring in *Vaucheria*, the divided protoplasm of the thallus producing a cellulose partition continuous with the original wall, and the thallus subsequently growing out by the side of this terminal partition.

When it is considered, however, that the protoplasm in *Vaucheria* is polynucleated, this apparent exception is rendered perhaps conformable to rule; and I may proceed at once to consider the reparative processes as they occur in the higher plants. And as the tissues of these differ in no essential respects, I shall limit myself to phanerogamous plants, and even further, chiefly to those which are exogenous.

The subject of repair may be considered as it occurs, first, after *amputation*; secondly, after *incision*; and, thirdly, as it occurs in the *artificial union* of parts in grafting and budding. And under each of these headings the process may be noted, so far as necessary, as it proceeds in the stem, in the leaves, or in the root.

First, then, in regard to amputation. If the growing peduncle of the Hyacinth (*Hyacinthus orientalis*, Linn.), be half cut across, the growth of the parts proceeds without manifest interruption, and the divided surfaces appear at the termination of growth scarcely altered. A longitudinal section, when placed beneath the microscope, displays the divided cells scarcely displaced, empty, yet preserving their form, and still bounding the chief part of the surface. The cells beneath those spoiled are rounded at those ends which are towards the wound, whilst their opposite ends are flat and adapted to the flattened ends of the adjoining elongated cells, as the ends of these cells are adapted to one another. Besides this, the ends of some of the entire cells may be found enlarged, bulbous, or clavate; and some may have pushed bud-like processes from the sides of their enlarged extremities. The changes apply equally to the medulla and to the cortical parenchyma. The divided fibro-vascular bundles are overlapped by the overgrown bulbous and divided cells †.

* 'Die Krankheiten der Pflanzen,' p. 97.

† Frank notices a similar mode of repair from the mesophyll in the leaves of *Leucojum vernum*.

If the plumule be amputated in the Bean-plant (*Faba vulgaris*, Mill.), the axis is reproduced by an adventitious bud; and the divided surface, if the plant be grown in the warm moist atmosphere of a greenhouse, is repaired in much the same manner, the new surface being formed by a layer of elliptical loosely arranged cells.

On submitting sections of either to the action, first, of iodine solution, and afterwards of sulphuric acid, they stain throughout of a deep blue. In neither case does there occur any formation of cork in the surface of the injury.

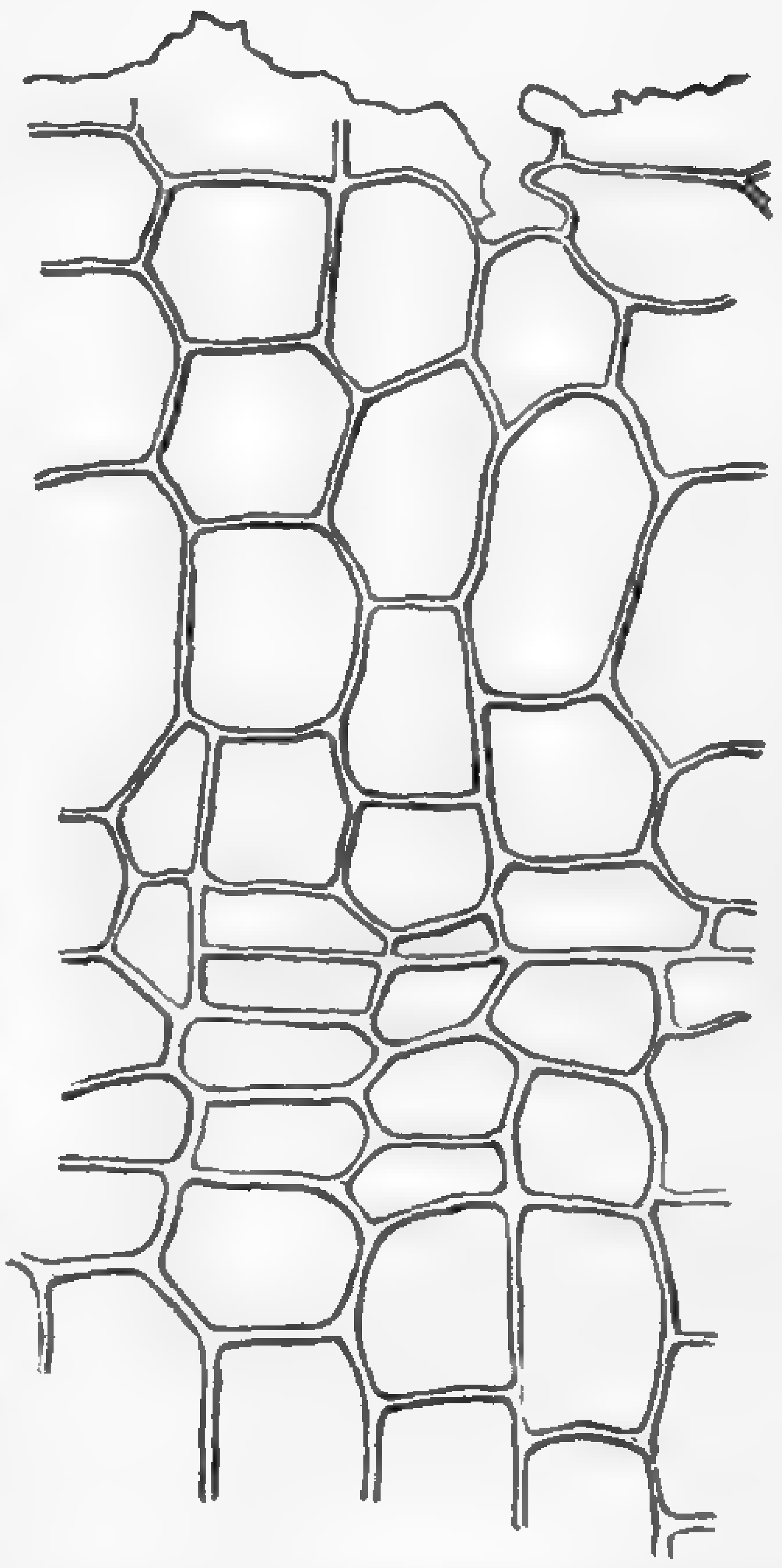
Frank observes, in the note before cited, that the new cells are indestructible by sulphuric acid, and are in this chemically different from the general parenchyma and resemble cork. But the repair in the case observed by him may have occurred under different conditions, since excess of moisture prevents the formation of cork, which is most readily produced in moderate dryness. In cases where the parts contain an abundance of sap, the process is modified by the formation of a scab of dry sap over the divided surface. For example, in *Ecbalium agreste*, on amputating a young leaf close to the growing procumbent stem, a copious flow of sap occurs from the vessels of the vascular bundles, and quickly forming a pellucid drop on the surface, dries as a firm glassy film through which the cut surface remains for some days clearly visible.

In the process of growth the layer of exuded sap is fissured, and the proper substance of the divided cells becomes exposed in its place. If the removal be made quite early, and the parts be examined microscopically some weeks afterwards, scarcely any change may be found to have occurred in the elongated parenchyma which forms the chief parts of such herbaceous stems and their subdivisions. Several layers of cells beneath the divided surface appear to be sharply outlined, and markedly different from the substance of the general parenchyma; but except at the very surface, these altered cells preserve their natural form. Beneath this encrusting layer, the cells may in some cases be found in certain spots less elongated, approaching to a flattened form; and in other cases, where the parts are allowed to attain full maturity, the living elongated cells have undergone oft-repeated divisions, so as thickly to cover the general tissue with cork and flattened subjacent phellogen.

But before such a new formation has had time to occur, the

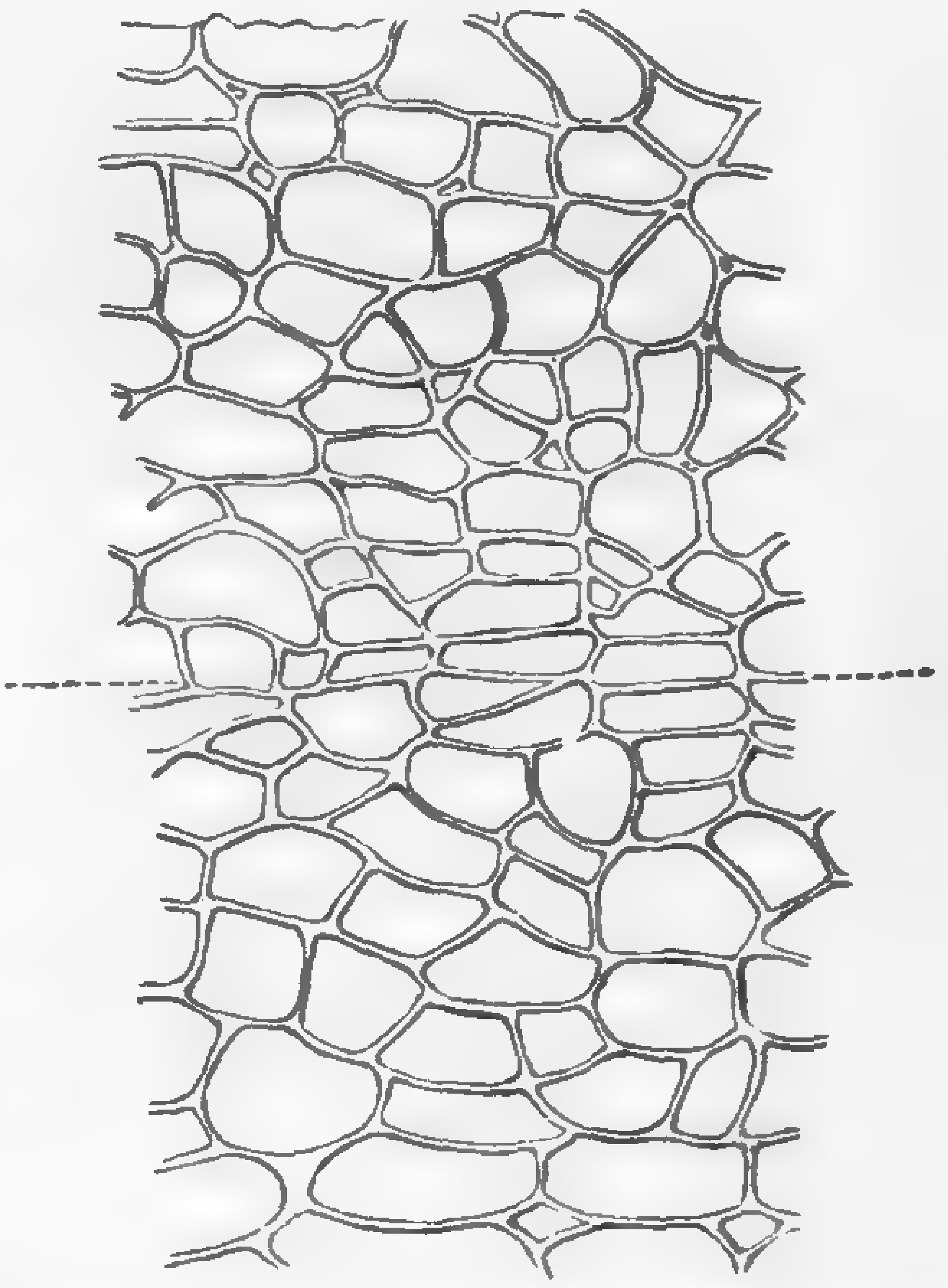
living parts, subjected to ordinary exposure, come to be nevertheless protected. I have noticed that in the earlier stages (such as may be seen fourteen days after the injury) the only change shown by the microscope will be that several tiers of the original elongated cells beneath the divided surface appear sharper in outline than those of the general substance, the altered layer being of uniform thickness and well defined from the rest of the parenchyma beneath, in which there may be in spots evidences of transverse partitioning. That the layer of altered cells has acquired new characters is shown by treating the section with iodine and sulphuric acid: whilst the general parenchyma is stained deep blue, these layers of surface-cells remain uncoloured, their walls having undergone a protective suberous change, though their elongated form shows these cells to be original elements of the petiole. This chemical change in the outer components of what is in its origin a single structure, may be compared in animal textures with the change in the outer cells of the cuticle, which are horny and not colourable with logwood, whilst those more deeply seated are wholly, or in part, of different composition and readily stained.

Fig. 1.



Section of *Ecbalium agreste.* Amputation through base of young petiole, repair after fourteen days, showing partitioning of the cells a short way beneath the surface.

Fig. 2.



Section of *Datisca cannabina.* Amputation through base of young petiole, repair after six weeks. Above the dotted line the tissue is suberous, the more superficial cells being unchanged in form, the deeper subdivided.

Similar changes are observable in the stems of *Datisca cannabina,* in the surfaces made by removing the portions which support the growing leaves. A thick layer of cork is formed of the original cells, most of which undergo subdivision to the second or third degree, forming short tiers of cells irregularly packed

together, and resting on a flattened subjacent phellogen; and similar ones are observable in the Hollyhock; and they may be assumed to be general in plants of the same longevity and like construction.

I have seen no proper cicatricial formation of cork in the Bean (*Faba vulgaris*, Mill.), whether grown under ordinary exposure or under the protective conditions of warmth and moisture. And it is perhaps true, generally, that the stems of herbaceous plants which last only one season, and in which no provision for leaf-fall exists, are incapable of such reparative process.

Indeed, in the Bean, when grown under the usual conditions, I have seen no change whatever in the parenchyma,—at the most a lesser readiness of the cells beneath the surface to react under the iodine and sulphuric-acid test; but even this change is irregular and undefined. Frank also notices this absence of repair in the same plant. He speaks, however, of an outgrowth of cells or callus from the cambium. I have observed such an outgrowth from the pericambium after amputation of the young root, but have seen no repair of an allied kind after removal of the stem, either in this or any other annual.

In *Ecbalium*, after amputation through the base of the young leaf-stalk, the ends of the fibro-vascular bundles killed in the division are raised from the deeper parts by the cell-multiplication. The spirals of the vessels may be found unrolled by the partitioning increase around, and stretched between the effete and the natural parts. In this way, by lateral compression, attenuation, perhaps rupture, the vessels are permanently closed beneath the temporary crust of sap.

Leaving the effects of amputation in trees for later consideration, the case may be next considered of those plants which are intermediate in structure and longevity between herbaceous annuals and exogenous trees. One of the most convenient to take is the common so-called Geranium, *Pelargonium* sp.

If a branch be removed near the parent stem, the cells injured by the division, together with several layers of those beneath, wither, and form a tough buff-coloured membranous layer, beneath which the growth of the living parts uninterruptedly proceeds. The process of growth being maintained in the subjacent parts, the inextensible incrusting substance becomes cracked, and its fragments disparted and loosened from the growing parts beneath,

so as finally to be completely separated. The surface will then appear silver-grey, dry, shining, and membranous; and contrasting with the earlier stages, both the ground-substance of the cortex and the pith are slightly convex, the zone of dead wood and bast being hidden in the furrow between. The new surface resembles in all its characters the general surface of the stem; and a microscopic section shows the central and peripheral parenchyma to be invested with a uniform layer of flattened suberous cells, closely arranged in tiers and set in rows on the subjacent surface. The new layer is continuous at the margin with the deeper part of the periderm.

The same steps of cork-formation may be here observed as were before noticed. A section treated with iodine and sulphuric acid will show, forming the actual surface, a crust of the original unaltered cells, dead, stained blue (as dead cellulose is), and still crammed with starch; beneath this the elements cease to give the cellulose reaction; and the cells are traceable in various phases of cross-multiplication, from the simplest most outwardly, with increasing degree and regularity, till the dividing parenchyma has produced a considerable thickness of tabular corky cells resting on an ordinary phellogen, the cells of which pass by gradations into the general parenchyma.

This is the ordinary mode of repair. But there may be added a formation of sclerenchymatous tissue in the pith a short distance beneath the flattened growth of cork described, the ground-tissue of the pith producing secondary meristem of elongated cells set across the axis of the amputated branch, the deeper of which cells undergo thickening and conversion into woody parenchyma. The medulla in such a case is closed by a dome of hardened tissue continued into the wood at its margin. The process recalls the closing of the medullary canal of the bone in an amputation-stump by new osseous tissue. The cap of new bone in such circumstances may be formed in the substance of the granulations which grow from the exposed medulla, though at other times it is produced in an intermediate fibrous membrane; and in the case which I have described the sclerosed tissue is formed of the indifferent cells of the pith and those to which these cells give rise.

Somewhat similar results are observable after the removal of branches in *Aucuba japonica* and the fleshy stems of Cactaceæ.

In *Cereus* the surface of an amputation is repaired as follows:—

Supposing the tissue to have been treated with iodine and sulphuric acid, a section will display on the general parenchyma a blue-stained phellogen, succeeded by flattened unstained cells of cork and a line of red or yellow sclerenchyma, two, three, or even four cells deep, these sclerotic cells being ranged in order with the flatter cork, and themselves succeeded by flattened suberous cells like those which lie beneath them; on the cork are larger cubical or spheroidal cells, the deeper unstained, those of the surface dead and deeply coloured blue.

Injuries of amputation in *Opuntia* are healed in a similar manner, a partition of sclerenchyma being formed so as to lie in the midst of the flattened corky layer. The thickening affects first the outer wall of the cell; and in later stages the outer walls of the cells, or those towards the surface, are often thickened in excess of those opposite. Yet this particular mode of repair is not so general in the Cactaceæ that it may be deemed a rule. In *Mammillaria*, for instance, repair is effected by tiers of tabular cork and phellogen without the formation of sclerenchyma.

The relationship which the new-formed cells bear to those of the general surface may appear, also, in the nature of their contents. Thus in the stems of *Cacalia articulata*, where the cells for two or three rows beneath the epidermis are flattened and hold cubical or rhomboidal crystals, the flattened cells of the repair beneath the cork contain similar crystals, whilst there are none such in the cortical parenchyma or in the cells of the pith.

It is interesting to observe, as showing some similarity to the reparative process as it occurs in Mammalia, that the cicatricial tissue does not acquire the full structure of that which it replaces. The new tissue is devoid of stomata, which on the stems of Cactaceæ are abundant; nor are such ever formed in, nor hairs upon it; as in animal scars, there are produced no sweat-glands or hair-follicles.

It is worthy of note also that the new covering does not spread from the edges of the original investment, but that its formation occurs simultaneously at all parts of the injured surface.

Now this process of healing is, in essential respects, parallel with the healing beneath a scab as it occurs in animal tissues—the form of healing which is most common in animals, and the general mode of the healing of open wounds in vegetable

tissues. But the spread of an epidermis from the margin of the wound, which occurs in animal tissues in the process of scabbing, does not take place in plants. No such lateral growth is observable after a partial removal of epidermis, whether the parts be left unprotected or kept beneath a bell-jar in an atmosphere saturated with moisture. In the latter case the cells exposed may preserve their vitality. After the removal of epidermis from the leaves of the Hyacinth, I have seen some of the denuded vertical cells elongated and club-shaped, as after partial section of the peduncle.

In *Agave* a many-layered covering of cork is produced on that portion of a leaf from which the original epidermis has been removed; and the same is true of succulent leaves, the repair being the same as that set up after the injury of an amputation.

On the Green Colour of the Hair of Sloths.

By H. C. Sorby, LL.D., F.R.S., F.L.S., Vice-Pres. Geol. Soc.

[Read April 7, 1881. Abstract.]

This paper in full, with a woodcut, will appear in the Society's Journal of Zoology, No. 87, vol. xv. p. 337. Ostensibly connected with a vegetable parasitic growth, the author has nevertheless treated the subject rather from a zoological point of view, or with more prominent bearings in that direction.

Dr. Seemann, in a letter quoted by Dr. J. Edw. Gray (Proc. Zool. Soc. 1871, p. 428), raised the question whether the green tint of the hair in certain species of Sloths might not be due to a parasitic Alga. The subject received no further attention in England, though it seems Welcker and Kühn had already published a memoir thereon in 'Abhand. der naturf. Ges. zu Halle' in 1866 (vol. ix. p. 20).

Mr. Sorby, with the advantage of studying fresh material (from the living animal) and not dried hairs (as had previous observers) of several species of Sloths, corroborates in a great measure Welcker and Kühn's observations. He enters into the structure and makes comparisons with the hair of several mammals; and thus shows that the hair of *Cholopus* differs in several particulars, and that the growth of the green Alga is most unmistakably related to this aberrant structure.

Welcker and Kühn found a difference in the parasitic plants

from *Bradypus* and *Cholopus*, naming them respectively *Pleurococcus Bradypi* and *P. Cholœpi*. Mr. Sorby regards them as possibly identical, the differences being rather due to conditions of growth than specific in character.

Mr. Sorby has made a spectroscopic examination of the Algæ found on *Cholopus*-hair, and compared the same with *Chlorococcum*, the analysis of which is as under-mentioned.

	Chlorococcum.	Sloth's hair.
Blue chlorophyll	48	53
Yellow ,, ...	10	17
Xanthophyll	16	17
Yellow xanthophyll.........	16	8
Orange ,, ...	6	1
Lichnoxanthine	4	4
	100	100

Note on *Hibiscus palustris*, Linn., and certain allied Species. By B. Daydon Jackson, Sec.L.S.

[Read April 21, 1881.]

When determining the modern equivalents for the old names given by Gerard in his 'Catalogus,' I assigned the name *Hibiscus palustris*, Linn., to the plant which then stood under the name of "*Bamia*, Strange Marsh Mallow." Subsequently Mr. W. B. Hemsley, in the 'Garden,' vol. xiv. (1879) p. 486, doubted the correctness of this determination, basing his objection upon the figure given in Gerard's 'Herball,' which is from the same block as that given by Tabernæmontanus in his 'Eicones.' I was at that time unable to recall the steps I had taken in arriving at my conclusion, and could only say that I had, as far as possible, ascertained the plant most probably intended by the old herbalist. Some time since, however, I recurred to the subject; and the outcome of these investigations into the history of it I now offer as a note to this Meeting.

Of the thirty species of *Hibiscus* named by Linnæus, there were two which chiefly concern us, namely, *H. Moscheutos* and *H. palustris*. The former was chiefly distinguishable by the peduncle being adnate to the petiole, the latter having the peduncle free in the axil of the leaf.

These two species were kept up as distinct by succeeding authors, Cavanilles illustrating them in juxtaposition on one of

his plates ('Dissertationes,' tab. 65). In 1806 Thore, in Loiseleur-Deslongchamps's 'Flora Gallica,' described a species of *Hibiscus* which grew in the department of the Landes as *H. roseus*, which name is to be found in the most recent local floras of France, *e. g.* Grenier and Godron (vol. i. p. 296), and of Italy, where it also grows, *e. g.* Parlatore (vol. v. p. 111). In 1838 Torrey and Gray ('Flora,' p. 237) merged the species *H. palustris* and *H. Moscheutos*, alleging that the chief character, the union of the petiole and peduncle, was inconstant even in the same plant; that therefore these forms could not be kept apart. The present aspect of affairs is, that whilst *H. Moscheutos* and *H. palustris* are considered to be one species by American botanists, *H. roseus* is in our European floras retained as distinct. I have examined the specimens of these species in the herbaria of Kew, the British Museum, of Linnæus, and of Smith; and the conclusion I have arrived at is, that whilst average specimens of *H. Moscheutos* and *H. palustris* are abundantly distinct, *H. roseus* is so near *H. palustris* as to be in many cases indistinguishable from it.

H. Moscheutos has the leaves decidedly lanceolate, upper surface nearly glabrous, the lower covered with fine pubescence. *H. incanus*, Wendl., has close relation to this by its general facies and its adnate peduncle; but the pubescence is very dense, as in our own *Althæa officinalis*, and marks the plant at first sight.

In *H. palustris* the leaves are more broadly ovate, the surfaces more nearly similar to each other in appearance, and the pubescence is rougher.

In *H. roseus* the leaves are inclined to be cordate, thus receding from the *Moscheutos* type; and the surfaces are precisely like those of *H. palustris*.

In all three species the lower leaves are apt to become tricuspidate.

I have very little doubt that *H. roseus* of Thore is the plant which the earlier writers had in view when speaking of *H. palustris*. An Italian specimen is preserved amongst the dried plants of Cesalpini, which were purposely put together in illustration of his system, dating from 1563, and forming the earliest type-collection known. Parlatore (*ut suprà*) and Caruel ('Illustratio in Hortum Siccum,' p. 110) cite this as having been recognized by them as *H. roseus*, Thore. Lobel, in 1570, speaks of the plant as "Althea palustris Cytini flore;" and his figure with the cordate

leaves shows them to be the same species; he knew it from Italy only. This figure was copied into Dalechamps, Parkinson, and Johann Bauhin's 'Historia,' the copies even repeating the error of six cells to the capsule. Another figure is that given by Tabernæmontanus as "*Althæa palustris*, Wasser Ybisch," the same cut being used in Gerard's 'Herball;' but the excellent figure of Dodoens is by far the best of the pre-Linnæan cuts. Cornuti's figure and description are rough, and he doubtfully refers his plant to the *Rosa Moscheutos* of Pliny, a plant which can hardly be determined with accuracy, since Pliny, speaking of Roses, only says:—"Alia funditur e caule malvaceo, folia oleæ habenda, moscheutos vocant" (Plin. Nat. Hist. lib. xxi. cap. 10).

It is, I think, much to be regretted that Torrey and Gray, in combining *H. palustris* and *H. Moscheutos* into one aggregate species, should have chosen the least appropriate name; but that is now too late to remedy. The *H. Moscheutos* of these authors is, I need hardly say, a species of more widely extended character than the species of Linnæus, since Linnæus specially excluded from it those forms having flowers springing free from the axils. I do not see how *H. roseus* can be kept up as a distinct species; it might be combined with the other two; but if not so united, it appears to me that it should bear the name of *H. palustris*, Linn. I may mention that there is no specimen of *H. palustris* in the Linnean Herbarium; but his description was drawn up from a plant in Burser's collection, from Caspar Bauhin's garden, so far as I understand the curt note in the 'Species Plantarum.' Burser had collected plants in Switzerland and Southern France, many of which he gave to Bauhin: afterwards he settled in Soroe in Denmark, and his collection became part of the spoils of war when Carl, King of Sweden, overran that country. Two volumes of the original twenty-five were lost in the disastrous fire which almost wholly destroyed the town of Upsala; the rarer plants were determined by Pehr Martin in the 'Acta scientiæ Seciæ,' and afterwards more at length by Linnæus in the first volume of the 'Amœnitates Academicæ.' Being a selection only, there happens to be no mention of our plant.

The Linnean specimen which does duty for *H. Moscheutos* may be that species; but it is deficient in the characteristics, only showing buds in a very immature state. There is no specimen of *H. palustris*.

This is a practical exemplification of the way in which the Linnean Herbarium is sometimes apt to disappoint those whose ideas of types are founded on modern practice.

[Since the foregoing was written, I have referred the matter to Dr. Asa Gray, who has given it as his opinion that our plant was probably an early introduction from America and not indigenous to Europe. This may be so; but it is very difficult, in the absence of evidence, to ascertain any thing certain about it; if it were intentionally brought over we might fairly expect to find it more widely dispersed and cultivated in gardens; if, on the other hand, it was accidentally introduced, it is curious not to find it near the ports of arrival at which the adventurers landed.]

I append references to those early authors who have noticed these plants.

HIBISCUS PALUSTRIS, *Linn.*, *Species Plantarum*, p. 693 (1753), ed. 2, p. 976 (1762).

Althea palustris Cytini flore, *Lobel*, *Adversaria*, p. 294 (1570); *id. Historia*, p. 374 (1576); *id. Icones*, p. 654 (1581); *Dalechamps*, *Historia generalis Plantarum*, vol. i. p. 1012 (1587); *Johann Bauhin*, *Historia*, vol. ii. p. 957 (1651); *Parkinson*, *Theatrum*, p. 305 (1640).

Althæa palustris, *Tabernæmontanus*, *Eicones*, p. 771 (1590); *Neuw Kreuterbuch*, vol. ii. p. 445 (1591), ed. 3, p. 1153 (1666); *Gerard*, *Herball*, p. 787 (1597), ed. *Johnson*, p. 933 (numbered erroneously "936") (1633); *id. Catalogus*, ed. 2, p. 3 (1599); *Caspar Bauhin*, *Pinax*, p. 316 (1623); *Mentzel*, *Pinax*, p. 17 (1682), excluding all synonyms except the first.

Althæa palustris ulmifolia, *Ammann*, *Suppellex*, p. 8 (1675).

Althæa hortensis sive peregrina, *Dodoens*, *Pemptades*, p. 643 (1583), ed. 2, p. 655 (1616).

H. MOSCHEUTOS, *Linn. loc. cit.*

Alcea rosea peregrina, forte rosa moscheutos Plinii, *Cornuti*, *Canadensium Plantarum Historia*, p. 144, tab. 145 (1635); *Morison*, *Historia*, vol. ii. p. 532, sect. 5, tab. 19. fig. 6.

On Central-African Plants collected by Major Serpa Pinto.

By Prof. Count FICALHO and W. P. HIERN, M.A., F.L.S.

[Abstract, read June 16, 1881.]

THE specimens herein discussed were collected by Major Serpa Pinto, during the month of August 1878, along the upper course of the river Ninda, an affluent of the Zambesi, on the west side of the high plateau. As regards the climate of this locality, the temperature is described as variable, the weather as very dry during seven or eight months of the year, and very wet during two or three months. The nature of the soil is metamorphic argillaceous schist; the latitude is 14° 46′ S., the longitude 20° 56′ E., and the elevation 1143 metres above the ocean.

The present little collection consists of seventy-two numbers, comprising sixty-five species in thirty-nine genera; more than a quarter of these species are new or not previously described and published, and at least one new genus appears amongst them. Some of the specimens are imperfect and have been difficult of final determination, especially the grasses and sedges; the greater part have had their approximate position ascertained; five specimens are hopelessly defective, and accordingly have been excluded from the examination.

As in the case of the previously known species, the affinities of many of those of the present collection are not only with the flora of Huilla, in South Angola, but also, in several instances, with that of extratropical South Africa; only a few of the species are widely distributed in the tropics of this and other continents.

This paper, with illustrations, will appear in full in the Society's 'Transactions.'

Notes on Gramineæ. By GEORGE BENTHAM, F.R.S.

[Read November 3, 1881.]

GRAMINEÆ, so long believed to be the largest Order amongst Monocotyledons, must now yield the palm to Orchideæ in respect of number of species; but they must still be acknowledged as immensely predominant, as well in individual numbers as in the part they take in the vegetation of the globe. The great majority of Orchideæ are very local, and amongst the few that are spread over wider areas it is frequently only in a few individuals dotted here and there; whilst a considerable proportion of Gramineæ are almost cosmopolitan in their geographical distribution within or without the tropics, often covering the ground with innumerable individuals. Orchideæ are difficult to preserve; collectors bring home but few specimens from their chief stations in tropical lands, and those few often imperfect. Their study is therefore surrounded by many impediments, and, with the exception of the few European ones, is in the hands of very few botanists; whilst Grasses, easily dried, abound in herbaria in specimens readily exhibiting their most essential characters; and every local botanist considers himself perfectly competent to describe as new species or genera suggested only by comparison with the few forms known to him from the same limited locality. The consequence is that amongst the large number of new species of Orchideæ described of late years the great majority (always excepting garden hybrids or varieties) appear to be really distinct; whilst the number of bad species and genera of Gramineæ with which science has been overwhelmed is truly appalling. Looking to the future, it is only probable that the preponderance in number of species of Orchideæ over Gramineæ is likely to be greatly increased as well by new discoveries among the former, as by a critical revision of old species of the latter. On the other hand, although the interest in Orchideæ has been so much intensified of late years, as well by the extent to which they are cultivated as by the singularities observed in their fertilizing-apparatus, yet their importance in the study of the history and development of vegetation, and in their application to the uses of man, remains as nothing compared to that of Gramineæ.

This paramount importance of the latter Order in an economical point of view has called forth innumerable treatises, memoirs, and essays on cereals, on forage and other cultivated grasses, on

meadows and pastures, on ornamental grasses, on the physiology and properties of the Order, &c., to which I need not further allude, my present object being merely to consider Gramineæ with reference to their classification and affinities. In a systematic point of view, the great mistake of Linnæus and the earlier systematists was the attempt to regard the whole spikelet as a single flower, with a calyx and corolla to be compared with those of the more perfect Monocotyledons. Robert Brown, with his usual sagacity, pointed out this and other errors, and first laid down the true principles upon which the Order could best be divided into tribes and genera; but he unfortunately took up the idea that the so-called lower and upper paleæ represented three outer segments of a perianth; and although this theory has long since been proved to be groundless, especially by Hugo Mohl, whose views have been fully confirmed by all subsequent careful observers, yet so great is the authority so deservedly attached to every thing that has issued from the pen of Brown, that his explanation of the structure of the spikelet is still allowed to influence the terminology adopted in generic and specific descriptions.

Shortly after the publication of Brown's 'Prodromus,' Gramineæ were taken up by several French botanists who had acquired materials, rich for the time, chiefly from North America and the West Indies. Some of these had already been published by Michaux or by Persoon, with more or less of assistance from Louis Claude Richard, to whom the credit of all that is good in Persoon's 'Synopsis' as well as in Michaux's 'Flora' has been attributed by several subsequent writers. The greatest value is justly attached to all of the elder Richard's observations in every Order that he worked up; and there is no doubt that such assistance as he gave to those two works added much to their importance; but we know that he declined to attach his name to Persoon's Synopsis, chiefly from an unwillingness to sanction the arrangement under the Linnean system, and we are by no means assured that there may not have been other details in both works which he did not concur in. We therefore are not justified in fixing on him a responsibility which he refused to undertake; and the genera and species first published by Michaux or by Persoon should be quoted as theirs and not Richard's, except where Richard's name is expressly attached to them. Michaux's 'Flora' was published in 1803, the first volume of Persoon's 'Synopsis' in 1805, both of them therefore antecedent to Brown; but two

other special agrostologists, Desvaux and Palisot de Beauvois, had ample time to avail themselves of Brown's work. Desvaux published his new genera in a memoir which first appeared in abstract in the 'Nouveau Bulletin de la Société Philomathique' for 1810, and afterwards in full in the first volume of his second 'Journal de Botanique' in 1813. Between these two periods Palisot de Beauvois published his 'Agrostographie,' in which he undertook a general arrangement of the whole Order, with definitions as well of the old-established genera as of a large number of new ones, including those of his contemporary Desvaux. The majority of these genera have since been adopted; but his arrangement of them was far too technical and his characters often so vague, that they could in most instances scarcely have been identified, were it not for the names of the species which he refers to them and for the really good analytical drawings accompanying his work. As it is, several of his names have been misapplied by subsequent botanists, who have not paid sufficient attention to, or have not seen, those drawings.

A few years later, three eminent botanists undertook the general study of Gramineæ. Kunth at Paris and afterwards at Berlin, Trinius in Germany and afterwards at St. Petersburg, and Nees von Esenbeck at Bonn, afterwards at Breslau, worked more or less contemporaneously, but with little or no communication with each other. Kunth's 'Revisio Graminum,' published in 1829 and following years, is a work not only splendidly illustrated, but remarkable alike for the accuracy of detail in the descriptions of species, as for several of the views given of their structure and arrangement. This work, however, is so costly as to be accessible to few botanists, and the more generally known first two volumes of his 'Enumeratio Plantarum,' containing the Grasses, were unfortunately a far too hasty compilation. He had entered into an agreement with old Cotta for the preparation of a compact Synopsis Plantarum on the plan of Persoon's, and had received a considerable sum of money on account of the work; but when it came to the actual drawing it up, Cotta insisted upon its being arranged according to the Linnæan system, which Kunth would no more agree to than did the elder Richard in the case of Persoon. The Synopsis or Enumeratio was therefore still in abeyance when old Cotta died; and his successors, not caring for the special plan adopted, insisted on an immediate return for the money advanced; and I several times heard Kunth himself much

bewail the necessity he was under of getting up these volumes without the care and study he could have wished to bestow on them, and which he did apply to his next volume on Cyperaceæ. Kunth also in all his works fully adopted Brown's theory as to the homology of the parts of the spikelet, carrying it out in detail to a degree which sometimes amounts almost to a *reductio ad absurdum*; as, for instance, in *Piptatherum* and *Milium*, two genera so closely connected in structure that they are still regarded by many experienced botanists as slightly different sections of one genus. In both genera we see the whole spikelet consist of two similar outer glumes without the slightest rudiment of a flower in their axis, and of a third glume enclosing a flower and its palea; and yet we are told that whilst in *Piptatherum* we have two glumes and one flower, we must in *Milium* consider them as one glume and two flowers.

Trinius published his 'Fundamenta Agrostographiæ' in 1820, something on the plan of Beauvois's 'Agrostographie,' but evidently founded on insufficient materials and bibliographical resources, and with some neglect of the already well-established rules of nomenclature. From that time, however, he devoted himself with the greatest zeal and increasing success to the study of the Order. I heard him say, *à propos* of some rather costly collection of specimens, that he would willingly sell his last coat for a new grass; and all his later works, down to his last papers worked up in conjunction with Ruprecht, and published in the Memoirs of the Petersburg Academy, are of the greatest value to agrostologists, though he never followed them up by any general synoptical view of the Order. In respect of terminology, he so far modified that of Kunth, that where a glume is theoretically supposed to have a flower in its axil, but really has not even the slightest rudiment, he does not, like Kunth, call it a whole (neutral) flower, but only half a flower.

Nees von Esenbeck never confined himself so exclusively to Gramineæ as did Trinius; he never published any general conspectus of the Order, and entered but little into general considerations of their structure and terminology; but he described with great care the grasses of various tropical and other extra-European regions; he had ample materials placed at his disposal, from the collections of Martius, Drège, Preiss, and other German travellers, and from the herbaria of Hooker, Arnott, and Lindley in this country, and he came to be regarded as the great autho-

rity for the determination of exotic Gramineæ. His 'Agrostographia Brasiliensis' is perhaps the best of all his works; and his Gramineæ for the 'Flora Africæ australis' is also very good. His generic and subgeneric groups appear to me to be often better, or at least more natural, than those of Kunth or Trinius; although they show in some degree that tendency to multiply genera as well as species, which he afterwards carried to so great an extent in Cyperaceæ, Laurineæ, and Acanthaceæ. Moreover, he worked up the grasses of each country separately, without paying sufficient attention to the cosmopolitan nature of so many species, which thus appear under different names in his different works. Brown's Australian *Panicum semialatum*, for instance, is raised by Nees to the rank of a genus under the name of *Coridochloa* in India, and that of *Bluffia* in South Africa, without any attempt at a comparison of the three plants.

The last general Enumeration of Gramineæ was that of Steudel, who published in 1855 the first volume of his 'Synopsis Plantarum Glumacearum,' the worst production of its kind I have ever met with. He was an excellent mechanical compiler; his 'Nomenclator Botanicus' was a most useful work; and if in the Grasses he had confined himself to collecting all the published species with references to or copies of their author's characters or descriptions, he would have rendered good service to the students of the Order; but beyond that, as he was no botanist, he was thoroughly incompetent for the task he had undertaken. Whenever he met with a grass which he could not readily make out, he set it down as new, with a new name, and a character so carelessly drawn up as to render its identification hopeless without recourse to the specimens themselves. Several of his new genera are well-known species repeated in the 'Synopsis' under their published names without recognition. A few, indeed, may have to be retained; but others, again, are founded upon the grossest errors, as, for instance, where he describes as a caryopsis the larva which had eaten up the ovary and taken its place in the enlarged pericarp. Having, moreover, no idea of methodical arrangement, his work is a perfect chaos.

Much has been done, however, for the elucidation of the Order in local Floras. Already at the close of last century and the commencement of the present one, several continental botanists proposed new genera for anomalous European grasses; but these were published in works which entered but little into general cir-

culation, and were overlooked by Beauvois, Persoon, Willdenow, and other general systematists. Several of the same genera have since been reestablished, but under other names which have now been so long and so universally adopted, that they must be considered as having acquired a right of prescription to overrule the strict laws of priority. It would indeed be mere pedantry, highly inconvenient to botanists, and so far detrimental to science, now to substitute *Blumenbachia* for *Sorghum*, *Fibichia* for *Cynodon*, *Santia* for *Polypogon*, or *Singlingia* for *Triodia*. Since the days of Kunth, Trinius, and Nees, the most important local revisions of Gramineæ are: Andersson's 'Gramineæ Scandinaviæ,' Parlatore's first volume of his 'Flora Italiana,' Cosson and Durieu's Glumaceous volume of the great unfinished 'Flore d'Algérie,' Doell's Gramineæ for the great Brazilian Flora founded by Martius, and Fournier's Gramineæ for the Mexican Flora he has undertaken; besides more partial revisions by Grisebach in his 'Spicilegium Floræ Rumelicæ et Bithynicæ,' in the fourth volume of Ledebour's 'Flora Rossica,' and in various contributions to the Floras of extratropical South America, the West Indies, the Himalayas, &c., and by Emile Desvaux in Claude Gay's 'Chilian Flora,' supplemented by new genera and species published by Philippi in various papers on Chilian plants. Andersson was a most acute observer, and had studied well the northern grasses of the old world; but from want of access to a sufficiently extensive library, his synonyms, especially when treating of extra-Scandinavian species, are often very inaccurate. Parlatore's detailed monograph of Italian grasses is thoroughly to be relied upon when the result of his own observations; but unfortunately neither he nor Andersson sufficiently distinguished the characters they had taken from other works from those they had themselves verified. Old errors, for instance, in the descriptions of the style or of the ripe fruit, which it is often very difficult to ascertain from dried specimens, have been in several instances repeated by both authors, sometimes in identical terms. Both of them also, especially Andersson, show a great tendency to the multiplication of genera and species. Cosson and Durieu's 'Monograph of Algerian Grasses,' comprising the chief portion of those of the rich West-Mediterranean Flora, is a most valuable treatise, both for methodical arrangement and specific distinctions. Grisebach has also done much for the elucidation of oriental Gramineæ. In Doell's work I have been disappointed. In many

instances I cannot approve of his distinctions or combinations of genera or species. That may, however, be a matter of opinion only; but in regard to several of the exceptional characters he gives, such as the five lodicules of *Pariana* or the three of *Aristida*, they have not been verified on reexamination; in his specific names he has not unfrequently departed from the established rules of nomenclature without giving any special reasons for so doing; and there is a general carelessness in redaction showing, for instance, on several occasions that when he had found reason to modify his first ideas as to the limits of species, he had neglected to revise his manuscript accordingly. He also makes frequent use of the expression "partis nomine," the meaning of which neither Munro nor myself, nor any of our classical friends to whom we have applied, can make out. Eugène Fournier's 'Enumeration of Mexican Gramineæ' is not yet published; but being already printed off, and M. Fournier having obligingly supplied me with a copy, I feel bound, in so far as I am concerned, to treat it as having already taken date. He has had at his disposal rich collections of the grasses of a country where they are perhaps more local and varied even than in South Africa; and he has made good use of these materials, although there is still much to be learnt with regard to Mexican forms. We have at Kew several, not only species but genera, which are not included in his work; and there are not a few of his which I cannot recognize in our generally rich Kew collections. A further comparison is also required with extra-Mexican genera and species, and especially with those of extratropical South America. His genus *Lesourdia*, for instance, had already been published for a southern species by Philippi under the name of *Scleropogon*. His *Trichloris* is represented in the south by two species separately recognized by Munro and by Jean Gay as constituting a distinct genus, but under names hitherto unpublished, which must therefore give way to Fournier's. In a systematic point of view also his work would have been much more useful if he had more frequently given the characters of the tribes, genera, or other groups which he has modified, instead of limiting himself to dichotomous keys. These dichotomous keys, when carefully drawn up, are of the greatest use as guides or indexes to direct the botanist where to look for his plant, but are wholly insufficient for its identification either generic or specific. For above sixty years I have had great experience both in using and in making them. It was with the

aid of the admirable "Analyses" in DeCandolle's 'Flore Française' that I was enabled in 1817 and 1818 to learn botany without any extraneous teaching; their principle was developed in the 'Essay on Nomenclature and Classification' which I published in 1823 as a French edition of Jeremy Bentham's 'Chrestomathia,' and I have introduced them more or less into all my local floras. I am thus well aware of the great difficulties in the way of drawing them up satisfactorily, requiring much testing before their final revision. They are chiefly useful where all, or nearly all, the plants of a country or of a group are well known; and even then they frequently require the repetition of the same plant under different branches of the key. The best genera and other groups are usually distinguished by a combination of characters, to each one of which there may be occasional exceptions, and these cannot be provided for in any key that presupposes limits definitely marked out by single characters. As a result, there are some of Fournier's groups which are evidently good, but to which we have no clue but that supplied by the species he includes in each. The two genera or subgenera, for instance, into which he divides *Bouteloua*, Lag. (*Eutriana*, Trin.), are natural and well limited; but the only character he gives, the prolongation of the rhachis of the spike beyond the last spikelet in the one and not in the other, is in fact variable in both groups. Of others, again, I can form no idea of the limits he proposes to assign them. In *Uniola*, for instance, he admits species (unknown to me) which do not appear from his description to have what we have been accustomed to consider as an essential character of the genus, the four to six empty glumes at the base of the spikelet. Where, therefore, I feel obliged to differ from him in the genus to which I would refer a species, it may as often be from the inability to ascertain what are his views as to the limits of a genus, as from that difference of opinion which so frequently prevails amongst the best of botanists.

In recent days, however, we had all been led to look up to my much lamented friend the late General Munro as the one who was to unravel the intricate web into which the order had become involved. His 'Monograph of Bambuseæ' and various detached papers and communications were instalments of great promise; he was known to have a thorough acquaintance with species, and to have already formed a well-digested framework for genera and tribes, an important sample of which he had given in the second

edition of Harvey's 'Genera of South-African Plants.' He had also amassed an immense number of notes on synonyms he had verified, on points of structure he had ascertained, &c., as materials for the general work he was preparing for DeCandolle's Monographs. His death has extinguished all such hopes as we had entertained; and although his notes, mostly dispersed in his herbarium or in the gramineous books of his library, are now left at our disposal at Kew, yet he had unfortunately not committed to paper his ideas on the limits and distinctive characters of tribes, genera, and subgenera not included in the South-African Flora; and these I could only gather from his conversation and correspondence. My own preparation for the work I have now undertaken was chiefly the study of European grasses for my 'Handbook of the British Flora,' and of Old-World Gramineæ generally for the 'Flora Hongkongensis' and 'Flora Australiensis,' when I was in constant correspondence relating to them with General Munro. Having now had to work also upon American forms and to examine with more detail the South-European, Oriental, and African ones, I have had to modify in some respects the views I had expressed as to the relative importance and constancy of some of the characters, and partially to rearrange some of the tribes and subtribes, although the general principles of classification which had been suggested by General Munro have only been confirmed by further experience.

I have already, in my paper on the classification of Monocotyledons (Journ. Linn. Soc. (Bot.) xv. p. 513), entered so fully into my reasons for adopting as to Gramineæ a terminology in accordance with the observations of Mohl and in harmony with that followed as to Cyperaceæ, that I need not repeat them on the present occasion. I would only add a few words in further reply to the objection repeatedly made to me that the falling off together of the flowering glume and palea (commonly called the two paleæ) enclosing the fruit, is a strong evidence of their being really homologous. But this is a mistake. A careful observation will show that they never do both together fall away from the rhachilla or axis of the spikelet; it is the rhachilla itself that breaks up, a portion of which always remains attached to the glume and palea and keeps them together round the fruit. In most Panicaceæ, especially in Andropogoneæ, the whole spikelet with the empty glumes as well as the flowering one falls off with the fruit. In the majority of Poaceæ the disarticulation takes place between each two

flowering glumes, leaving the intervening portion either attached to the glume next above it, when it is usually described as a callus proceeding from the glume, or to the glume next below it, when it is often half concealed between the keels of the palea and taken no notice of; or if it be a continuation of the rhachilla above the last glume, it is often termed a neuter or abortive flower. The cases where the flowering glume really detaches itself ultimately from the inarticulate and persistent rhachilla are very few, chiefly in several species of *Eragrostis*, where the glume and caryopsis fall away, leaving the palea and floral axis persistent on the rhachilla. In some cases the apparently terminal fruiting glume enclosing the palea and caryopsis falls away without any perceptible portion of the rhachilla above or below it; but that arises from the disarticulation taking place so close under it that the fragment carried off is only that minute portion actually embraced by the base of the glume.

The homology of the glumes of Gramineæ, whether empty or flowering, with those of Cyperaceæ may now be considered as generally admitted; and a total absence of perianth in the former order might not be regarded as improbable when we have traced in Cyperaceæ its gradual reduction from the regular hexamerous perianth of *Oreobolus* to its absolute deficiency in *Cyperus* and others. But we have in Gramineæ a new element on the floral axis below the stamens and pistil or actual flower, in the *palea* and *lodicules*, for which we cannot at once find any parallel in other orders, and which have been very variously accounted for. They have very recently been the subject of a very able paper in Engler's 'Botanische Jahrbücher' (i. p. 336) by Professor Hackel of Vienna. He comes to the conclusion that the palea and the pair of lodicules (when two only) are each of them single, more or less bifid, organs, and that they and the third lodicule, when present, must be regarded as two or three bracteoles inserted alternately fore and aft on the floral axis below the flower. And he has made out a good case in favour of his view, but perhaps not an unanswerable one. The first objection that strikes one is that the difficulty of finding any homologues in other orders is by no means diminished. In other orders where bracteoles do exist below the flower, they are usually lateral with reference to the main axis, not fore and aft, never more than two, unless when representing a continuation, as it were, of the sepals, and never developed, to my knowledge, when the perianth is suppressed;

the bracts performing the functions of the deficient perianth are always, I believe, on the main axis, like the glumes of Gramineæ. Then, again, the perfect union of the two lobes of the palea or of the two lodicules, or even the occasional development of a single central nerve or central lobe, is no absolute proof that they are not in fact double organs; for where the segments of a perianth are united in a tube or cup, the lateral nerves of two adjoining segments (sepals or petals) often coalesce into a single one which may protrude at the top into an intermediate tooth or lobe. Hackel has well shown that the unity or duplicity is the same in the case of the palea and of the two lodicules; but it is only conjecturally that he continues the parallel through the third lodicule, which, when present, never shows any tendency to division, and whose insertion is not perceptibly higher up than that of the two others. It is quite true that it is often much smaller than the other two, sometimes very minute; but in several species of *Stipa*, in the majority of Bambuseæ &c., I have seen the three quite equal and perfectly similar. The only instances I know of more than three lodicules are those of *Ochlandra*, where they are exceedingly irregular, and of *Reynaudia*, where I find four in two pairs, as described and figured by Kunth; but then the outer pair, although closely contiguous (on the opposite side of the floral axis) to the upper ones, appear to me to represent the palea which is otherwise deficient. The minute bodies above the lodicules in the female flowers of *Pariana*, which Doell mistook for additional lodicules, appear to me to be rudimentary staminodia; they are very minute and irregular, and not always to be found.

I have observed that the search for homologues to the palea and lodicules in the Orders nearly allied to Gramineæ has met with but little success. The only representation of the palea that I can find is that mentioned in my above-quoted paper (Journ. Linn. Soc. (Bot.) xv. p. 516), where it is compared with the hypogynous scales of *Hypoelytrum pungens* and *Platylepis*; and I find that in some species of *Eriocaulon* (Flora Australiensis, vii. p. 190) the perianth is composed of two outer segments inserted near the base of the floral axis and two or three inner ones close under the andrœcium, or these inner ones occasionally deficient, the arrangement passing gradually through other species to the normal two contiguous series of two or three each. It might therefore be suggested that the palea and lodicules of Gramineæ represent perianth-segments of an outer and inner series, although I by no

means pretend to assert it as a proved fact. If the suggestion be confirmed, we might be justified in designating as a neutral flower that in which the palea alone, or the palea and lodicules without stamens or pistil, are developed; but we must not include in the flower the bract or glume which subtends it.

In all cases the palea, whatever its origin, is called upon in conjunction with the subtending glume to perform more or less of the functions of the deficient or absent perianth, and thus acquires a certain fixity of character, and requires mention in all full generic characters. The lodicules, on the other hand, are generally rudimentary representatives of suppressed organs having lost all functional powers, and their slight variations in form or consistency are generally not even of specific importance, and they only require mention in generic characters in the few cases where they have retained a greater and more constant development.

There is much of interest in the question of the geographical distribution of Grasses as compared with that of Orchideæ, and in the consideration of the causes which have produced the differences observed in the two Orders, amongst which perhaps the very different agencies through which cross-fertilization is effected may be most influential; these questions may have also more or less bearing on tribual and generic arrangement; and there are numerous observations which I should have been desirous of recording. This, however, would lead to speculations which it would not be safe to indulge in without a far more detailed and closer study of ascertained facts than I have time to carry out; and I feel obliged to confine myself on the present occasion to the purely systematic consideration of real or supposed affinities and diversities.

The division of the Order into tribes and subtribes is a matter of exceptional difficulty. Whatever tribes have been proposed, whatever characters have been assigned to them, there have always been more or less ambiguous forms uniting them and preventing the restricting them within absolutely definite limits. We are obliged in Gramineæ, more perhaps than in any other Order, to rely upon combinations of characters, allowing for occasional exceptions in every one of our groups, preferring those which experience has shown to present the fewest aberrations. Following up these views, none of the general divisions of the Order hitherto proposed have proved to be more natural or more definite than Brown's original primary one into two great groups or suborders—*Panicaceæ*, in which the tendency to

imperfection is in the lower flowers of the spikelet; and *Poaceæ*, in which the tendency is in the opposite direction. This indication of the principle kept in view is too indefinite to serve as a practical character; but, combining it with that proposed by Munro of the articulation in the axis of the spikelet being below the spikelet itself (in the pedicel) in Panicaceæ, and above the lowest glume or none in Poaceæ, the exceptional forms are reduced to the lowest possible figure. This primary division, although tacitly approved of by many partial agrostologists, has not been generally adopted in systematic works, and many attempts have been made to divide the Order according to more positive characters, but as yet with but little success.

Kunth entirely gave up Brown's primary groups and divided the Order into thirteen tribes, many of which were natural, fairly defined by a combination of characters, and have been very generally adopted. Others have been objected to on various grounds. He attached too much importance to such characters as the separation of the sexes or the increase in the number of stamens, which are exceptional in different groups rather than tribual distinctions; in the general arrangement, his removal of the Andropogoneæ to a distance from the Paniceæ is disapproved of; and his describing flowers as actually existing when only theoretically imagined is sometimes misleading. Nees generally adopted Kunth's tribes, but improved the circumscription of some of them, and added two or three small ones. Trinius never completed his revised arrangement of the Order. Since the time, however, of these great agrostologists, systems have been sketched out which require a few words of notice.

Fries, followed by Andersson, proposed for a primary division of Gramineæ that into *Clisantheæ*, with the flower (*i. e.* the flowering glume and palea) closed and the elongated styles protruding at the apex, and *Euryantheæ*, with the glume and palea open at the time of flowering and the short styles protruding laterally. This division is, however, practically useless, except perhaps for the limited number of species that can be observed in a living state. The flowers of most species open only for a very short time, and in dried specimens are almost always closed. The styles, again, are in many cases so exceedingly slender and fugacious as to be very difficult to observe in dried specimens, except in the bud, when they have not yet attained their full development, or after fertilization, when they are withering away.

The long styles, moreover, would place the majority of the subtribe Seslerieæ, for instance, among Panicaceæ, when all their other characters are those of Poaceæ; and the species are very numerous in which, from the intermediate length of the styles, or from both the lower smooth part and the stigmatic portion, or the lower part alone, being described as styles, they are differently characterized as long or short by different writers.

Fournier rejects both Brown's and Fries's primary divisions, but proposes a new one founded on the position of the lowest glume of the spikelet, next to the main axis in Chlorideæ and Hordeaceæ, and averted from it or external in other tribes. But, in the first place, this relative position cannot well be ascertained in loosely paniculate Gramineæ, where there is so frequently a slight, almost imperceptible torsion of the pedicel, and, in the next place, in one-flowered spikelets it is often uncertain which is to be regarded as the lowest glume. The total number of glumes in the tribe Paniceæ, for instance, is variable, according to the genus or section, two, three, or four; the lowest in *Reimaria*, and in a few species of *Paspalum*, corresponds to the second in the majority of *Paspala* and a few allied genera, and to the third in *Panicum*. All these genera are included by Fournier, as by all others, in one and the same tribe; and if so, are we to regard as the outer glume the small outer one of *Panicum*, called by some an extra bract, and an imaginary one in *Paspalum* and its allies, or the outer one of *Paspalum*, which is second in *Panicum*? Again, in one and the same genus, the relative position of the outer glume and the main axis is not always constant, as, for instance, in *Paspalum*, in Nees's section *Digitariæ* (*Emprosthion*, Doell, *Anastrophus*, Schlecht.), the outer glume and the flowering one above it are external, whilst in the majority of the genus they are turned towards the central rib of the main axis, and yet the two groups are not distinguished by Fournier even as sections.

Another character much insisted on of late years for tribual distinction is still more uncertain, the adherence of the ripe grain or caryopsis to the palea, as in *Festuca*, *Bromus*, &c. This is usually very conspicuous in the dry state, although even then the grain is often only closely embraced by the palea, and when moistened the adherence very generally disappears. The union of the two is perhaps never truly organic, and in hot water I have always found them readily separable without any tearing.

The consequence is that there are a considerable number of species in which the grain has been described by some as adherent and by others as free, and which have consequently been transferred from one genus to another. Yet, if not taken too absolutely, the character is sometimes a useful one, assisting, for instance, in the arrangement of the genera of some of the subtribes of the difficult tribe Festuceæ.

Considerable importance was attached by the earlier agrostologists to the presence or absence of the awn on the back or apex of the flowering glume; but this has subsequently been found to be subject to great variations. The spiral twist, however, in the lower part of the awn in some genera is more constant, and in the 'Flora Australiensis' I had taken it as an essential character of some tribes or subtribes; but there are more exceptions than I was then aware of. The awn, when present, is generally twisted in Andropogoneæ, Tristegineæ, Agrostideæ, and Avenaceæ, and not in Paniceæ, Chlorideæ, Festuceæ, or Hordeæ; but it is sometimes very slightly so in a few species of the latter group, and in the former tribes, where the awn is much reduced, if there be any twist it is scarcely perceptible. In all the tribes, also, the awn is occasionally, and in the straight-awned ones frequently, altogether deficient; and in some genera, as in *Stipa* for instance, where it is usually twisted, there are exceptional species in which it is straight or curved only. The character must therefore generally be used with more or less of reservation.

The partial or absolute separation of the sexes or the increase in the number of stamens observed in a few genera have been occasionally introduced amongst tribual characters; but further observation has shown that they occur amongst Gramineæ of very different affinities, and have thus proved to be often of no more than generic value, although in one tribe, the Maydeæ, the absolute unisexuality of the spikelets may be constant.

Differences in the size of the embryo, in the form of the so-called scutellum on the caryopsis (indicative, apparently, of the hilum of the seed), or in the longitudinal groove or cavity frequently observable on the caryopsis, have been sometimes brought forward as absolute generic, if not tribual, characters, and they may often be really important; but we know, as yet, too little about them to test their value fairly. Herbarium specimens rarely supply ripe fruits, and they have been carefully observed

and accurately described in comparatively few species. The characters thus ascertained in a single one have been supposed to belong necessarily to the whole genus; and when differences have afterwards been found in some other species, it has at once been generically separated, without ascertaining whether these differences might not be reconciled or connected through other species. Before, therefore, we can ascertain the real generic value of characters which cannot be tested in herbarium specimens, it is necessary that we should have them well and authentically described in a much greater number of species from actual observation. I have on several occasions had reason to believe that, in long-detailed descriptions drawn up by accurate botanists from dried specimens, the seminal characters have been rather guessed at on theoretical grounds, than actually verified on really ripe seeds.

Following out the views of General Munro as to the general arrangement of the Order in as far as I have been able to ascertain them, we have divided it into tribes and subtribes, of which the following are the most prominent characters, omitting for the present exceptional forms, which occur in almost all of them:—

A. Panicaceæ. Spiculæ cum pedicello infra glumas articulatæ, flore fertili unico terminali, addito interdum inferiore masculo v. sterili.

Tribus i. **Paniceæ.** Spiculæ hermaphroditæ, rarius abortu unisexuales, spicatæ v. paniculatæ, rhachi inflorescentiæ inarticulata. Gluma florens exaristata, fructifera indurata v. saltem exterioribus rigidior.

Tribus ii. **Maydeæ.** Spiculæ unisexuales, masculæ terminales spicatæ v. paniculatæ v. (in *Pariana*) fœmineam circumdantes, fœmineæ inferiores spicatæ, cum rhacheos internodio (excepta *Zea*) articulatim secedentes.

Tribus iii. **Oryzeæ.** Spiculæ hermaphroditæ v. rarius unisexuales, paniculatæ v. spicatæ, rhachi inflorescentiæ inarticulata. Gluma sub flore summa (palea?) uninervis v. carinata.

Tribus iv. **Tristegineæ.** Spiculæ hermaphroditæ, secus paniculæ ramulos inarticulatos solitariæ v. rarius geminæ v. fasciculatæ, cum pedicello articulatæ. Glumæ vacuæ aristatæ v. muticæ, florens hyalina v. tenuiter membranacea, arista geniculata terminata v. mutica.

Tribus v. **Zoysieæ.** Spiculæ hermaphroditæ v. nonnullæ imperfectæ, cum rhachi inarticulata spicæ simplicis sigillatim v. fasciculatim articulatæ. Gluma florens membranacea, sæpius vacuis minor hyalinaque.

Subtribus 1. Anthephoreæ. *Spiculæ in pedicello 3–∞, in fasciculum deciduum confertæ. Gluma florens nunc vacuis sublongior, nunc brevior hyalina.*

Subtribus 2. Euzoysieæ. *Spiculæin pedicello solitariæ, rarius geminæ. Gluma florens vacuis brevior, hyalina.*

Tribus vi. **Andropogoneæ.** Spiculæ secus spicæ rhachin v. paniculæ ramulos, sæpissime geminæ v. terminales ternæ, in quoque pari homogamæ v. heterogamæ. Gluma florens vacuis minor, hyalina, sæpe aristata.

B. Poaceæ. Pedicellus infra glumas continuus. Rhachilla supra glumas inferiores persistentes sæpe articulata, ultra flores fertiles producta, stipitiformis v. glumas vacuas v. flores imperfectos ferens, v. interdum flos fertilis more Panicacearum unicus terminalis, sed cum gluma sua a vacuis persistentibus articulatim secedens.

Tribus vii. **Phalarideæ.** Flos hermaphroditus unicus, terminalis. Glumæ 6 (v. 5 et palea) uninerves v. carinatæ.

Tribus viii. **Agrosteæ.** Spiculæ 1-floræ, rhachilla ultra florem nuda v. in setam v. stipitem producta.

Subtribus 1. Stipeæ. *Panicula laxa v. irregulariter spiciformis. Gluma florens arista sæpius terminata, fructifera caryopsin arcte involvens. Rhachilla ultra florem non producta.*

Subtribus 2. Phleoideæ. *Panicula spiciformis densa, cylindracea v. subglobosa. Gluma florens mutica v. aristis 1–3 terminata fructifera caryopsin laxe includens. Rhachilla interdum producta.*

Subtribus 3. Sporoboleæ. *Panicula laxa v. ad racemum reducta, rarissime spiciformis. Gluma florens mutica. Caryopsis demum sæpius glumis apertis subdenudata. Rhachilla non producta.*

Subtribus 4. Euagrosteæ. *Panicula varia, sæpius laxa. Gluma florens sæpius arista dorsali instructa, rarissime mutica. Caryopsis gluma laxe inclusa. Rhachilla sæpe producta.*

Tribus ix. **Isachneæ.** Spiculæ æqualiter biflora. Glumæ sæpius muticæ. Rhachilla ultra flores non producta.

Tribus x. **Aveneæ.** Spiculæ bi- v. pluriflora, sæpius paniculatæ. Glumæ florentes arista dorsali v. interdum terminali sæpissime instructa. Rhachilla ultra flores sæpius producta.

Tribus xi. **Chlorideæ.** Spiculæ uni- v. plurifloræ, secus rhachin spicarum unilateralium biseriatim sessiles, secundæ.

Tribus xii. **Festuceæ.** Spiculæ bi- v. plurifloræ, varie paniculatæ v. rarius racemosæ. Glumæ florentes muticæ v. aristis terminatæ.

Subtribus 1. Pappophoreæ. *Glumæ florentes plurinerves tri- pluriaristatæ, v. absque aristis quadrilobæ.*

Subtribus 2. Triodieæ. *Glumæ florentes uni- v. trinerves, tridentatæ, trifidæ v. triaristatæ.*

Subtribus 3. Arundineæ. *Rhachilla sub glumis florentibus longe pilosa.*

Subtribus 4. Seslerieæ. *Inflorescentia spiciformis v. capituliformis, basi glumis vacuis v. spicis sterilibus sæpius stipata. Stylus v. rami sæpius longi tenues.*

Subtribus 5. Eragrosteæ. *Glumæ florentes trinerves. Cætera normalia.*

Subtribus 6. Meliceæ. *Glumæ florentes tri- v. plurinerves, superiores duæ v. plures vacuæ, semet involventes.*

Subtribus 7. Centotheceæ. *Folia plana, lanceolata v. ovata, inter venas transverse venulosa. Glumæ florentes quinque- v. plurinerves.*

Subtribus 8. Eufestuceæ. *Glumæ florentes quinque- v. plurinerves. Cætera normalia.*

Tribus xiii. **Hordeeæ.** Spiculæ uni- v. plurifloræ, ad dentes seu excavationes rhacheos spicæ simplicis sessiles.

Subtribus 1. Triticeæ. *Spiculæ ad nodos solitariæ, tri- v. plurifloræ, rarius bifloræ.*

Subtribus 2. Leptureæ. *Spiculæ ad nodos solitariæ, uni- v. bifloræ. Spica tenuis.*

Subtribus 3. Elymeæ. *Spiculæ ad nodos geminæ v. plures collaterales.*

Tribus xiv. **Bambuse** . Gramina elata, sæpius basi saltem lignosa. Folia plana, sæpissime cum vagina articulata. Spiculæ uni- v. plurifloræ. Lodiculæ sæpius 3. Stamina 3, 4, v. plura.

Subtribus 1. Arundinarieæ. *Stamina* 3. *Palea bicarinata. Pericarpium tenue, semini adnatum.*

Subtribus 2. Eubambuseæ. *Stamina* 6. *Palea bicarinata. Pericarpium tenue, semini adnatum.*

Subtribus 3. Dendrocalameæ. *Stamina* 6. *Palea bicarinata. Pericarpium crustaceum v. carnosum, a semine liberum.*

Subtribus 4. Melocanneæ. *Stamina* 6 *v. plura. Palea* 0 *nisi glumis simillima. Pericarpium crustaceum v. carnosum, a semine liberum.*

I now proceed to a more detailed revision of the several tribes, subtribes, and genera, in the order in which I have worked them up for the forthcoming part of our 'Genera Plantarum,' to which I must refer for the technical characters and references, as well as for the synoptical clavis of the genera.

Series A. PANICACEÆ.

This first main division of Gramineæ is very fairly defined by the combination of two characters—the articulation of the pedicel below the spikelet or cluster of spikelets, and the single fertile flower apparently terminal, with or without a single male or sterile one below it. Where either of these two characters fails, the plant should be referred to Poaceæ.

The articulation of the pedicel is usually immediately below

the lowest glume, leaving, as the spikelet falls away, a slight dilatation or callosity at the apex of the persistent portion. Sometimes it is not easily observed at the time of flowering, but becomes more marked as the fruit ripens. A similar marked articulation has not hitherto been observed in Poaceæ, except in *Fingerhuthia*. There are also a very few cases where the lowest glumes are reduced to slight callosities, or are so rudimentary as to render it difficult to say whether the articulation is in the pedicel or in the rhachilla. In the *Cenchrus* group of the tribe Paniceæ, in the subtribe Anthephoreæ of Zoysieæ, and in some Andropogoneæ, the articulation is not under each spikelet, but under a little cluster of two or more spikelets; and in Maydeæ it is the rhachis of the spike which disarticulates under each female spikelet. In Gramineæ generally, however, the articulation, whether of the rhachis, of the pedicel, or of the rhachilla, is usually under the fertile spikelets or flowers only; under the males it is apt to be very obscure or quite obsolete.

The fertile flower is above spoken of as only *apparently* terminal, because the presence of the palea and a slight obliquity tend to show that the floral axis is not really the continuation of the rhachilla, but, as in Poaceæ, a secondary or axillary branch. Doell says, indeed, that a continuation of the rhachilla behind the palea has been observed in a species of *Panicum*; but I have never succeeded in meeting with it in any Panicaceæ. In the tribe Oryzeæ, where there is no two-nerved palea, it may still remain a matter of doubt whether the floral axis is or is not distinct from the rhachilla—whether the uppermost scale is a glume on the rhachilla or a palea at the base of the floral axis. The presence or absence of a central nerve is not an absolute test; for it is occasionally, though very rarely, absent in the lower glumes.

Panicaceæ have never more than four glumes, the uppermost one usually enclosing or subtending the fertile flower, though in some Andropogoneæ it is excessively reduced or even quite obsolete or rudimentary. The next under it may be empty like the lower ones, or may enclose a palea, a rudimentary flower, or a perfect male flower, and in *Beckmannia*, and a very few species or individuals of *Setaria* and *Panicum*, this lower flower may be hermaphrodite, but usually, if not always, sterile. The two lower glumes when present are always empty. Where the spikelets are unisexual, the females have only the single terminal flower, the males most frequently two flowers, both with perfect stamens.

The tribes composing the series of Panicaceæ run much into each other, and have been very variously extended or reduced. We have adopted the following six, as having appeared to us to be rather better defined than the smaller or larger ones that have been proposed.

Tribe I. Paniceæ.

The principal character of the Paniceæ, considered as a tribe of Panicaceæ, consists in the hardening of the fruiting glume. In several of the smaller genera, however, and even in some species of *Panicum* itself, it is membranous, but usually larger than the outer ones, and forming the chief covering of the fruit, never hyaline or much reduced as in Andropogoneæ. *Oryzopsis*, *Milium*, and their allies, which were formerly included in Paniceæ, have been transferred to Agrostideæ on account of the persistent lower glumes below the articulation. Among the other general characters of the tribe, the inarticulate rhachis of inflorescence is constant except in *Stenotaphrum*, where, however, the articulation is very tardy and not constant, so that it has often been denied. The flowering glume never bears the twisted awn, so general in Andropogoneæ and Tristegineæ, although in *Eriochloa* and a very few species of *Panicum* its obtuse apex has a short, erect, almost dorsal point; the awns of *Oplismenus*, *Chætaria*, the section *Echinochloa* of *Panicum*, &c. are straight and terminate one or more of the empty glumes only. The fertile flower terminating the spikelet is, in the normal genera, either perfectly hermaphrodite, or, at any rate, as far as I have observed, has staminodia round the pistil. It is only in a few of the abnormal genera added to the tribe that there are strictly female spikelets.

The normal genera of the tribe may be distributed in four rather distinct groups, though scarcely marked enough to be raised to the rank of subtribes; and to these we would add a few more or less abnormal genera, but little connected with each other, but all apparently more nearly allied to Paniceæ than to any other tribe.

In the first group, or *Paniceæ proper*, we have distinguished eleven genera—a number somewhat arbitrary; for much might be said in favour either of uniting the whole into one vast genus *Panicum*, or of dividing them still further, as some have proposed, into about twice as many as those here adopted, the distinctive characters being often either very uncertain, or such as are not universally recognized as generic in the Order.

1. Reimaria, Flügge.—This old-established and universally acknowledged genus has generally been limited to two tropical and subtropical American species, with a peculiar slender habit and inflorescence, and characterized by having only one empty glume below the flowering one, and by the constant reduction of the number of stamens to two. It has since, however, been ascertained that several species which cannot well be separated from *Paspalum* have only a single lower empty glume; and Doell has distinguished *Reimaria* chiefly by the reduction of the stamens, together with the form of the spikelets more acuminate and more closely appressed to the rhachis than in any *Paspalum*. He has added, under the name of *R. aberrans*, a third species, which, with a more vigorous habit, rather invalidates the natural distinction from *Paspalum*, but has all the characters of *Reimaria*; and Munro recognizes a fourth species, allied to *R. aberrans*, but with only two, or at most three, spikes to the panicle and a much thicker rhachis, in the Florida plant distributed by Curtis with the number 3566 as *Paspalum vaginatum*, but probably not the one entered under that name in Chapman's 'Flora of the Southern United States.' It occurs also in Wright's Cuban collection under n. 3854, and may be characterized as *R. oligostachya*, Munro, spicis in pedunculo 2 rarius 3 (nec 6–15), rhachi dilatata spiculis sublatiore. The true *Paspalum vaginatum*, Sw., is a synonym of *P. distichum*, Linn.

2. Paspalum, Linn., ranks among the large genera of tropical Gramineæ, and in respect of the greater number of species is a natural one, readily distinguished from *Panicum* by the inflorescence and by the technical character of the deficiency of the small lowest glume. It is now, however, ascertained that neither character is quite constant. A few *Panica* of the section *Brachiaria* have the inflorescence of *Paspalum*; and the lowest glume is frequently reduced to a small callus, or is entirely deficient in the section *Digitaria*; and the consequence has been, that several species have been referred by some botanists to the one genus and by others to the other. These ambiguous species appear, however, to be best placed in *Panicum*; and all true *Paspala* have the spikelets sessile or nearly so, in two or four rows along the lower or outer side of the rhachis of the spikes or simple branches of the panicle, and they show no trace of the small lowest glume of *Panicum*. Thus defined, the number of species may be estimated at about 160, by far the greater proportion of them tro-

pical American, a few of which are also generally spread over the warmer regions of the Old World, especially *P. distichum*, Linn. (*P. vaginatum*, Sw.), which reaches southern Europe as an introduced weed. Scarcely five species can be regarded as belonging exclusively to the Old World. The above estimate of the total number is founded chiefly on the investigations of Munro, who had nearly completed the working-up of the genus, and has left full descriptions with diagnoses and synonymy of 138 species, besides a few that he had left for further inquiry. Steudel enumerates 262 species, but nearly half of them have proved to be mere synonyms or very slight varieties. Doell describes in detail 105 Brazilian species; but some of them are what I cannot consider as really distinct; and his own views of them were any thing but stable, as there are several which he at one time referred to one species and later transferred to another, forgetting to eliminate them from their former place, thus:—

Gardner, n. 2354, is repeated under *P. malacophyllum* and *P. subsesquiglume*.
Hostmann, n. 658, under *P. densiflorum* and *P. cæspitosum*.
P. distachyum, Salzmann, n. 667, under *P. pumilum* and *P. divergens*.
Gardner, n. 3496 and 3497, under *P. maculosum* and *P. notatum*.
Gardner, n. 2975, under *P. vaginatum*, *P. tropicum*, and *P. filifolium*.
P. cæspitosum, Hochst., n. 1543, *P. amazonicum*, Trin., and *P. humile*, Steud., } under *P. plicatulum* and *P. dissectum*.
Digitaria uniflora, Salzm., n. 659, and Spruce, n. 679, } under *P. platycaulon* and *P. furcatum*.
P. surinamense, Hochst., n. 1283, under *P. furcatum* and *P. scoparium*.
Spruce, n. 30, under *P. chrysodactylon* and *P. chrysoblephare*.

Fournier enumerates 40 Mexican species, of which thirteen are described as new; but he is, in Gramineæ, generally disposed to admit as distinct species forms which I perfectly agree with Munro in regarding as slight varieties, corresponding to what so many local European botanists describe as critical species.

With regard to the subdivision of the genus, Trinius, in his several revisions, distributed the species chiefly according to the size of the spikelets, which, however much it may affect the general aspect of the species, is in many cases far too uncertain a character to be practically useful. Nees, in his 'Agrostologia Brasiliensis,' proposed six sections, which Doell reduced to four,

Munro, though he had so nearly completed his descriptions of species, and often indicated the sections to which he referred them, had not yet definitively grouped them, leaving his manuscripts, for convenience of reference, in alphabetical order. We have adopted three sections, founded on Nees's, which appear to us well defined by positive characters—*Eupaspalum*, *Cabrera*, and *Anastrophus*, subdividing the first, and largest, into four groups or subsections, *Anachyris*, *Opisthion*, *Pseudoceresia*, and *Ceresia*, much less marked in their outlines, but generally speaking fairly natural.

Eupaspalum comprises the great majority of the species, and is distinguished by the spikelets strictly secund along the rhachis of the spikes, with the back of the flowering glume and of the lower empty one (when present) turned outwards—that is, away from the rhachis or from its midrib; whilst in *Anastrophus*, which includes the remainder of the genus except the monotypic *Cabrera*, the spikelets are almost distichous, and the back of the flowering glume and of the lower empty one turned towards the midrib of the rhachis. This distinction was specially relied upon by Nees under the terms *spiculæ adversæ* and *spiculæ inversæ*, and followed up by Doell. It is not alluded to by Fournier with regard to the Mexican *Paspala*; but, if I understand correctly his words (Gram. Mex. p. vii), it nearly corresponds to the character he proposes for the primary division of Gramineæ.

Anachyris, the first subsection of *Eupaspalum*, is a purely artificial one, characterized solely by the having only a single empty glume below the flowering one. It was first proposed as a genus by Nees for the *Paspalum malacophyllum*, Trin., which has all the habit and floral and other characters of *Paspalum* except this single one; and Fournier, apparently on this account, transfers it to the tribe *Oryzeæ*. Doell, however, reduces it to a section of *Paspalum* under the name of *Eremachyrion*, associating with it a few other species, some of them evidently more nearly allied to corresponding species of the section *Opisthion* than to each other. And even the technical character is not always constant; for in *P.* (*Eremachyrion*) *sesquiglume*, Doell, a species closely allied to *P.* (*Opisthion*) *maritimum*, Trin., I frequently find a minute outer glume; and, again, *P. pallidum* and *P. candidum*, H. B. K., both of which Doell places in *Eremachyrion*, are scarcely to be distinguished from each other except by the lowest empty glume absent in the one, present in the other, as originally pointed out by

Kunth. Nees describes the palea (upper palea) of the typical *Anachyris paspalodes* or *Paspalum malacophyllum* as 3-nerved; Fournier says it is 1-nerved. The species is very variable as to the size of the spikelets, the hairs or setæ on the rhachis of the spike, &c.; but in all the specimens I have examined I have uniformly found the palea normally 2-nerved.

Opisthion, proposed by Doell as a section of *Paspalum*, is our second subsection of *Eupaspalum*. It includes all the typical *Paspala* with two lower empty glumes, and the rhachis of the spikes not dilated. The species are numerous and varied, but scarcely reducible to distinct groups.

Pseudoceresia is a subsectional name I should propose for the genus *Ceresia* as understood by Elliott and other North-American botanists. In it the rhachis of the spikes is more or less dilated and concave, but green and herbaceous throughout, and the spikelets are small and glabrous or nearly so. The species are few, including *P. stoloniferum*, Bosc, *P. repens*, Berg., and their allies. *Ceresia* is the name we would reserve for our fourth subsection, being the genus *Ceresia* as originally established by Persoon, in which the dilated rhachis of the spikes is bordered by a coloured or smooth membranous margin, and the half-enclosed spikelets are larger than in *Pseudoceresia* and densely ciliate. Besides several Brazilian and other tropical species, it includes the Mexican *P. cymbiforme*, Fourn.

Cabrera, our second section of *Paspalum*, is limited to the single *P. aureum*, H. B. K. (not of Trinius), forming Lagasca's genus *Cabrera*, in which the direction of the spikelets is nearly that of *Anastrophus*; but instead of being marginal on each side of the rhachis, they are deeply embedded in alternate cavities on each side of the midrib, on the outer or lower side of that rhachis. This remarkable arrangement is very well described by Lagasca, who was a most accurate botanist. His 'Nova Genera et Species Plantarum,' forming part of the 'Elenchus Horti Matritensis,' is a model for the clearness and conciseness of the characters given, which are most thoroughly to be depended upon. The work is quoted by Nees and by Doell, but evidently at second hand; had they really read it, and had they studied Kunth's good figure and description, they could never have given to the *P. aureum* the new name of *P. immersum*, or have transferred the synonym of *Cabrera chrysoblepharis*, Lag., to the *P. exasperatum*, Nees, or to the supposed distinct *P. chrysoblepharis*, Doell, both of them at

complete variance with Lagasca's description. The genus *Axonopus*, Beauv., sometimes given as a synonym of *Cabrera*, because Beauvois had suggested that *P. aureum* might possibly be a congener, was founded on various heterogeneous species of *Paspalum* and *Panicum*; and the name has to be wholly expunged.

Anastrophus, our third section, was proposed as a genus under that name by Schlechtendahl, and includes Nees's section *Digitarieæ* or Doell's *Emprosthion*. It is characterized by the position of the spikelets on the alternate margins of the narrow, somewhat flexuose rhachis of the spike, so as to be rather distichous than secund, and by their direction, the back of the flowering glume and of the lower empty one being turned outwards or away from the rhachis. The spikes are also generally several close together at the end of the peduncle, as in the section *Digitaria* of *Panicum*, suggesting to Nees his sectional name, which, however, is inconvenient as being adjective in form, and too liable to be confounded with the true *Digitaria*. Some of the species have, like *Cabrera*, long cilia on the spikes, but have otherwise all the characters of *Anastrophus*, of which they might form a subsection under the name of *Lappagopsis*, given by Steudel to the *P. dissitiflorum*, Trin., which he proposed as a distinct genus. The several species which we would include in the subsection show a curious diversity in the position of the cilia: in *P. fastigiatum*, Nees, they are long on the empty glumes, none on the rhachis; in *P. senescens*, Nees, short on the empty glumes, long on the rhachis; in *P. dissitiflorum*, Trin., long both on the rhachis and on the empty glumes; and in a few other species, referred by Nees and by Doell to *Cabrera*, although without the peculiar characters of Lagasca's genus, the rhachis alone is fringed with long cilia, the glumes having none.

Paspalum saccharoides, Trin., referred by Kunth to *Panicum*, is one of those small-flowered species which seem to connect *Paspalum* with *Panicum* (*Digitaria*), whilst the long silky hairs of the spikes and the consistence of the glumes show an approach to the *Andropogoneæ* (*Sacchareæ*). The arrangement of the spikelets along the rhachis, the number of glumes, &c. show a nearer affinity to *Paspalum* than to any other genus.

3. Anthænantia, Beauv. (*Aulaxanthus*, Ell.), was founded upon two North-American species, with the hairy inflorescence and membranous glumes of the section *Trichachne* of *Panicum*, but without the small lowest glume of that genus; and the second

glume (corresponding to the third of *Panicum*) usually encloses a palea or a male flower—a circumstance unusual in the Order, where the exposed glumes are almost always empty. From these I cannot separate generically the South-American *Leptocoryphium*, Nees, which, besides some slight specific characters, only differs from the North-American species in the second glume being constantly, instead of occasionally only, empty. The genus *Anthænantia* thus constituted includes three species—*A. villosa*, Beauv. (*Aulaxanthus ciliatus*, Ell., *Panicum ignoratum*, Kunth), *A. rufa*, Benth. (*Aulaxanthus rufus*, Ell., *Panicum rufum*, Kunth), and *A. lanata*, Benth. (*Paspalum lanatum*, H. B. K., *Milium lanatum*, Kunth, *Leptocoryphium lanatum* and *L. molle*, Nees).

4. Amphicarpum, Kunth, with spikelets unisexual by abortion and a peculiar inflorescence, remains limited to the single North-American species on which the genus was founded.

5. Eriochloa, H. B. K. (a name having the right of priority over *Œdipachne*, Link, and *Helopus*, Trin.), has the habit rather of the section *Brachiaria* of *Panicum* than of *Paspalum*, but wants the small lower glume of the former genus, and differs generally from both in a peculiar callous thickening of the pedicel at the articution. There are, however, a very few species with more or less of this callosity, which on other accounts cannot well be separated from *Panicum*. The flowering glume has also the peculiar point on the obtuse apex observable in *Panicum helopus*, Trin., and in a few others, and supposed to characterize a section or genus *Urochloa*. It is, however, an uncertain character, both in *Eriochloa* and in *Panicum*. Nearly twenty supposed species of *Eriochloa* have been described; but the greater number of them are scarcely even varieties of the *E. polystachya*, H. B. K., which is widely spread over the warmer regions of the Old as well as the New World, and known under the various names of *E. punctata*, *E. annulata*, &c. There appear also to be at least four really distinct species—*E. distachya*, H. B. K., and *E. grandiflora* (*Helopus*, Trin.) from tropical America, *E. trichopus*, Hochst., from tropical Africa, and *E. villosa*, Kunth, from eastern Asia.

6. Beckmannia, Host, is a single species, ranging from eastern Europe across Russian Asia to North America. It has been usually placed in Phalarideæ, a tribe with which it appears to me to have but little connection. The habit and inflorescence are those of *Panicum colonum*; but it is exceptional in Paniceæ as having both the flowers hermaphrodite; the lowest flower is,

however, as far as I have observed, usually sterile; and a similar character is to be found in some species or varieties of *Setaria*, and very rarely in *Panicum* itself, next to which the genus appears to be best placed. The synonym *Joachimia*, Ten., given by Kunth, was a name intended for it by Tenore, but I believe never actually published. Tenore figures the plant as a *Beckmannia*.

7. Panicum, Linn., after deducting *Ichnanthus*, *Oplismenus*, *Setaria*, and several smaller genera, remains one of the larger, and probably the largest, among tropical Grasses, and is still in many respects polymorphous. In habit and inflorescence it may be confounded sometimes with *Paspalum*, sometimes with *Arundinella*, or even with some Agrosteæ. Generally speaking, it may be easily recognized by technical characters; but the most marked, the very small size of the lowest empty glume, is not quite constant; for in a few species this glume is wholly deficient as in *Paspalum*, whilst in a few others it is of the size of the second glume; the hardening also of the fruiting glume and palea is in some species very slight. There is nothing, however, sufficiently definite or constant in these exceptional species to mark them out as intermediate genera; and here, as in so many other cases of large genera of Cyperaceæ and Gramineæ, we must admit the existence of forms which must be placed in one or the other of allied genera from considerations of convenience rather than of strict character. Taking the genus *Panicum* within the limits we have ascribed to it, nearly 800 supposed species have been published: Steudel enumerates 716; Doell has 134 Brazilian ones, Fournier 97 Mexican, Nees 44 South-African; I described 54 Australian ones; and they are rather numerous in tropical Africa and Asia; but a considerable number are repeated in several or even in all of these Floras, and a large proportion of Steudel's species are mere synonyms or blunders. The total number of fairly distinct species can therefore scarcely be estimated at much above 250. These have been variously grouped, chiefly according to their inflorescence; and no less than eighteen supposed genera have been at different times separated from it, but are now reunited, either as being founded on insufficient, uncertain, or even mistaken characters, or as being, in our opinion, more conveniently regarded as sections than as genera. But, even as sections, their limits are often as far from being absolutely definite as are those of the whole genus. The following eleven are those which have appeared to be the most distinct; but they are all more or less

connected by intermediate forms, and several of them would probably be modified, and may hereafter be much improved, by a closer study of species than I have at present been able to bestow upon them.

(1) *Digitaria.* Spikelets usually small and in alternate pairs or clusters along one side of the simple spike-like branches of the panicle; those of each pair or cluster unequally pedicellate, or one of them almost sessile, and the lowest glume often very minute or sometimes quite deficient. This section was proposed as a distinct genus in Walter's 'Flora Carolinensis' under the name of *Syntherisma*, and by Richard, in Persoon's 'Synopsis,' under that of *Digitaria*, and is still maintained as such by many botanists. It was founded originally on the cosmopolitan weed *Panicum sanguinale*, Linn., in which the spike-like branches of the panicle are clustered at the end of the peduncle like those of *Cynodon* and some other Chlorideæ. There are now, however, nearly forty species to be included in the group, in many of which the spikes or branches are distant along the peduncle, as in *Schedonnardus*, *Gymnopogon*, *Leptochloa*, &c., among Chlorideæ. From this tribe the structure of the pedicellate spikelets and their articulation always keep them perfectly distinct; but there is a series of small-flowered species, including the Australian and Asiatic *P. parviflorum*, Br., *P. tenuiflorum*, Br. (*Paspalum brevifolium*, Flügge), and *Paspalum minutiflorum*, Steud., and two or three from South Africa, which have been almost equally well placed by some in *Paspalum*, by others in *Panicum*. As in some species allied to *P. sanguinale*, and even in some varieties of *P. sanguinale* itself, the minute outer glume is frequently absolutely deficient. The more pedicellate spikelets and the occasional, however rare, appearance of the outer glume may justify the placing these species rather in *Panicum* than in *Paspalum*, to which I referred them in the 'Flora Australiensis.' *P. platycarphum*, Trin., from Bonin Island, with all the characters of true *Digitaria*, is remarkable for the dilated membranous rhachis of the spike-like branches as in the section *Ceresia* of *Paspalum*.

(2) *Trichachne.* In this section, distinguished as a genus under that name by Nees and others, the branches of the panicle are simple as in *Digitaria*, but usually few, loose, scattered along the peduncle, and erect. The glumes are all, or the second ones alone, ciliate or clothed with soft hairs as in the section *Tricholæna*; and the fruiting glume is not much hardened. The species

are few: *P. semialatum*, Br., is widely spread over the Old World, for I am unable to distinguish the Asiatic *Coridochloa*, Nees, and the South-African *Bluffia*, Nees, from Brown's Australian species; *P. Gayanum*, Kunth, is confined to tropical Africa; *P. leucophæum*, H. B. K., is frequent under various names in the tropical and subtropical regions of the New and the Old World. It is a very variable species; and specimens gathered at different stages of development look very different from each other, but are not separable into marked varieties. It was included by Beauvois in his genus *Urochloa*, and appears to have been the type of the proposed genera *Acicarpha*, Raddi, *Eriachne*, Philippi, and *Holosetum* and *Mesosetum*, Steud., and is probably the principal element of Presl's supposed genus *Alloteropsis*.

(3) *Diplaria*. This section is proposed for a few American species with a simple terminal spike-like inflorescence. The spikelets are sessile along the rhachis in two rows and distichous, as in the section *Anastrophus* of *Paspalum*, from which *Diplaria* differs technically in the presence of the small outer glume characteristic of *Panicum*. It comprises *P. rottboellioides*, H. B. K., *P. exaratum* and *P. ferrugineum*, Trin., *P. pappophorum*, Nees, and a few others.

(4) *Thrasya*, distinguished as a genus by Kunth, has a simple terminal spike-like inflorescence as in *Diplaria*; but the rhachis is more or less dilated as in the section *Ceresia* of *Paspalum*, and the spikelets, sessile along the midrib, although really alternate and biseriate, have all the appearance of being in a single row. The species are few, all American, and include, besides the original *Thrasya paspaloides*, Kunth, the *P. ansatum*, Trin., which is scarcely specifically distinct from it, *P. thrasyoides*, Trin., *P. petræum*, Trin., and perhaps two or three others. The *P. petræum* forms the genus *Tylothrasya* of Doell, which he characterizes by a callous thickening of the pedicel like that of *Eriochloa*; but the plant is in all other respects too closely allied to the typical *Thrasya* to be generically separated, and the callosities are slightly prominent in various species of *Panicum*.

(5) *Harpostachys*. The inflorescence is again simple and spike-like; but the spike is more or less falcate, with the spikelets crowded in two or four rows along one side of the slender rhachis, as in Chlorideæ, and the common peduncles are usually long and often clustered two or three together in the upper axils. To this section belong *P. monostachyum*, H. B. K., *P. decumbens*, R. et Schult., and *P. subfalcatum*, Doell.

The genus *Dimorphostachys* of Fournier is founded upon the above *P. monostachyum* and some other American species, which we should refer to the sections *Digitaria* or *Brachiaria*, but which he connects generically by the small lowest glume being more developed or differently shaped in one spikelet of each pair than in the others; but the difference is often exceedingly slight, and the character so little connected with any other or with habit, that it seems difficult to attach any more than specific importance to it.

(6) *Brachiaria.* This section, sometimes referred to as *Paspaloid Panica*, comprises a large number of species both from the New and the Old World, in which the inflorescence is that which is regarded as specially characteristic of *Paspalum*: the panicle consists of a number of spike-like simple branches, distributed along a simple common peduncle; but the small lowest glume of *Panicum* is always present. If we regard only such typical species as *P. flavidum* or *P. fluitans* of Retz, or *P. paspaloides* of Persoon, the section appears a most distinct one; but, on the other hand, several such species as *P. adspersum*, Trin., *P. argenteum*, Br., *P. Petiveri*, Trin., *P. polyphyllum*, Br., &c. so closely connect it with some of the sparingly-flowered species of *Eupanicum*, as to make it impossible to draw a precise line of demarcation between the two. Amongst these intermediate forms, *Paractænum*, proposed as a genus by Beauvois, appears to be only a starved state of *P. gracile*, Br.

P. helopus, Trin., bears on the obtuse apex of the flowering glume a short point, like that of most species of *Eriochloa*, and was therefore joined by Beauvois to the *P.* (*Trichachne*) *semialatum*, Br., to form his genus *Urochloa*; but the two are in other respects too dissimilar to be united in one section, and *P. helopus* appears to be altogether a true *Brachiaria*.

(7) *Echinochloa*, was regarded by Beauvois as a distinct genus, founded chiefly on two very widely-spread and most variable species, *P. colonum*, Linn., and *P. crus-galli*, Linn., the former often cultivated, the latter a most abundant tropical and subtropical weed. Both have nearly the inflorescence of the section *Brachiaria* but they are coarser plants, with the spikelets densely crowded on the partial spikes or branches of the panicle, and the second and third empty glumes, in the one rarely, in the other very generally, terminating in long awns. It was probably on this account that Kunth united Beauvois's *Echinochloa* with his

Oplismenus; but the development of the awn has now been shown to be so frequently uncertain in one and the same species of Gramineæ, that the character has quite lost the absolute importance once attributed to it by Beauvois and others, and *Echinochloa* is generally admitted only as a slightly distinct section of *Panicum*. The true *Oplismenus* may, however, be well maintained as a separate genus, to which I shall presently refer.

(8) *Ptychophyllum* has been well worked up as a very distinct section of *Panicum* by A. Braun. It comprises *P. plicatum*, Lam., from the Old World, *P. sulcatum*, Aubl., from America, and a few others, which, with a peculiar foliage, have more or less of setæ in the panicle, which seem to connect them with *Setaria*. On examination, however, these setæ will be found in *Ptychophyllum* to be merely the setiform tips of the ultimate spikelet-bearing branches of the panicle, whilst the bristles or setæ of *Setaria* are abortive branchlets, forming a kind of involucre below the spikelets. The remaining floral characters of *Ptychophyllum* are entirely those of the loosely-panicled species of *Eupanicum*.

(9) *Hymenachne* of Beauvois, often retained wholly or partially as a genus, comprises a small number of species both from the New and the Old World, in which the small, very numerous spikelets are usually crowded in a long narrow cylindrical spike-like panicle. In the typical species, *P. myurus*, Linn., the spikelets are rather acuminate and the fruiting glume scarcely hardens; in *P. indicum*, Linn., and others the spikelets are small, and quite those of a large number of true *Panica*.

(10) *Eupanicum*. After deducting the nine preceding sections and the succeeding *Tricholæna*, which have all some distinguishing peculiarity, there remain a large number of species strictly normal in the structure of their awnless spikelets, and connected together by their more or less spreading panicle, the spikelets, on short or on slender pedicels, clustered or scattered along its simple or divided branches. These species, in number not far from two hundred, may vary much in the size of the spikelets, in the degree of development of the panicle, and in other minor points, but seem little capable of being classed in distinct subsections. They form Trinius's two sections *Virgaria* and *Miliaria*, characterized by the branches of the panicle being angular in the one, terete in the other—a distinction which I have been quite unable to follow out, at least in the dried specimens. All I have been able to suggest has been their distribution into seven groups or series,

vaguely distinguished chiefly by their inflorescence and general habit. Amongst the somewhat exceptional species are *P. uncinatum*, Trin. (*Echinolæna polystachya*, H. B. K.), in which the three empty glumes are nearly equal to each other, though shorter than the flowering ones, and *P. pterygodium*, Trin. (forming the genus *Otachyrium*, Nees), in which the two lower empty glumes are about equal, but shorter than the third. In all the others the lowest empty glume is much the shortest. *Coleatænia*, from extratropical South America, is proposed as a genus by Grisebach as having diœcious flowers. I have not seen any specimen; but from his description it seems to be in all other respects a true *Panicum* (*Eupanicum*); and as he has only seen the male, evidently with the flowers still young, he may have overlooked the pistil, or its abortion may not be constant. At any rate that character standing alone can scarcely be sufficient to separate it generically. Several of the cultivated Millets are species of *Eupanicum* with large, loose, often nodding panicles.

(11) *Tricholæna* (including Nees's genus *Rhynchelytrum*), raised by Parlatore and some others to the rank of a genus, has the loose panicle of *Eupanicum*; but the fruiting glumes are not much hardened, and the whole inflorescence is ciliate with long hairs as in *Trichachne*, on which account the oldest known species, the widely-spread *P. Teneriffæ*, was originally published as a *Saccharum*. There are now about fifteen species known, chiefly South-African; but one, the above-mentioned *P. Teneriffæ*, extends to the Mediterranean region, two are East-Indian, and two or three South-American. *Rhynchelytrum*, Steud., is a different genus from Nees's, and belongs to the Tristegineæ.

8. Ichnanthus, Beauv., is so closely allied in habit and general character to some species of *Panicum* (*Eupanicum*) that it is perhaps rather in deference to the authority of all the principal recent agrostologists, than from any conviction of our own, that we retain it as a distinct genus. The character is a purely technical one—a thin hyaline auricle or wing to the rhachilla on each side close under the flowering glume, as is observed in some species of *Cyperus*. In the species forming the section *Macropteris* of Doell these auricles are often more than half as long as the glume itself; in *I. longiflora* (*Panicum longiflorum*, Trin.) they are very small, but prominent; in *I. pallens* and its allies, forming Doell's section *Micropteris*, they are often scarcely perceptible, and Fournier has restored these species to *Panicum*, though Munro

keeps them up as *Ichnanthus*. Two species, *I. Hoffmanseggii*, Doell, and *I. oplismenioides*, Munro, are remarkable for the long spreading hairs, which give them a very peculiar aspect. There are altogether about twenty species, all tropical American.

9. Oplismenus, Beauv. (*Orthopogon*, Br.), though very near the section *Brachiaria* of *Panicum*, appears to be a natural genus, and is well characterized by the greater development of the lowest empty glume, which is, moreover, always awned, whilst in *Panicum* it is much smaller than the others and always unawned. Kunth adopted the genus, but, relying on the awns alone, united with it *Echinochloa*, in which the proportions of the glumes are the ordinary ones of *Panicum*, and which I have referred to above as a section of *Panicum*. Fournier adopts Kunth's view. Steudel and Doell both reduce the whole to *Panicum*. The true *Oplismeni* are widely spread over the warmer regions both of the New and the Old World, and are variable as to the number and length of the spikes or panicle-branches, &c. Some botanists adopt above thirty species, others reduce the whole to varieties of a single one; it is probable that some three or four may be fairly distinguished as species. *Hekaterosachne* of Steudel is one of the common forms of *Oplismenus*.

10. Chætium, Nees, to which Doell has properly referred *Berchtoldia* of Presl as a second species, has nearly the spikelets of *Oplismenus*, to which Kunth reduces it, the outer glumes being much more developed and awned than the flowering ones; but, besides some minor points, the inflorescence appears quite different enough to justify the maintaining it as a distinct genus. Doell considers it as a section of *Panicum*, with two species, one Brazilian, the other Mexican. Fournier retains the genus *Berchtoldia* for the Mexican one, without comparing it with *Chætium*, and adds two supposed new Mexican species: the one, *B. holciformis*, judging from the specimens he quotes, is one of the large coarse forms of *Panicum* (*Echinochloa*), very nearly allied to, if not varieties of, *P. crus-galli*; the other, *B. oplismenoides*, is unknown to me, but must from his description be referable also to *Echinochloa*.

11. Setaria, Beauv., was included by the older authors in *Panicum*, and has been restored to that genus as a section by Steudel and by Doell, but is retained by most modern botanists as a well-marked natural genus, easily recognized by the dense spike-like panicle usually bristling with numerous setæ issuing

from the pedicels below the spikelets. These setæ are not epidermal like the rigid hairs of many Gramineæ, but, as in *Pennisetum*, are supposed to be abortive branchlets of the panicle, differing, however, from those of the latter genus by being inserted below the articulation of the pedicel, so as to remain persistent after the fall of the spikelet. The species are very variable, and a large number have been described as distinct; they appear, however, to be reducible to about ten, three of which are common weeds over a great part of the civilized world, and a fourth (*S. italica*) has been much cultivated as one of the Millets of the Mediterranean region and the Levant. The genus was first fully characterized by Beauvois in his 'Agrostographie,' chiefly from the above-mentioned common weeds; but he had previously published and figured, in his Flora of Oware and Benin, under the name of *Setaria longiseta*, a plant which, as far as I can judge without seeing the specimen, proves to be no *Setaria* at all, but the *Pennisetum* (*Beckeropsis*) *unisetum*, to which I shall presently refer. A few species or varieties of *Setaria*—one, for instance, gathered by Hildebrandt in the Sandwich Islands, allied to *S. viridis*, another, not uncommon in the Mexicano-Texan region, allied to *S. italica*—have, like the variety of *S. glauca* figured by Trinius, t. 195, the lower flower hermaphrodite as well as the upper one, which is quite exceptional throughout all genera of Paniceæ except *Beckmannia*. *Ixophorus*, Schlecht. in Linnæa, xxxi. 420, was founded as a genus on *Urochloa uniseta*, Presl, a Mexican grass which we do not identify in our collections; but Trinius refers it to *Panicum* and Fournier to *Setaria*, with which Schlechtendal's description agrees very fairly.

In our second or *Cenchrus* group of Paniceæ we include four genera, chiefly tropical or subtropical, characterized by the so-called involucre of bristles surrounding each spikelet or sometimes each cluster of two or three spikelets; this involucre, supposed to represent abortive branchlets of the inflorescence, being placed above the articulation of the pedicel, always falls away with the spikelets; the spikelets themselves are quite those of *Panicum*, the inflorescence usually a simple spike raceme or spikelike panicle, rarely a loose panicle of two or more pedunculate spikes. 12. CENCHRUS itself, as reduced from the original Linnean genus, consists of about a dozen species, both from the New and the Old World, two or three of them of very wide geographical range, all characterized by the numerous bristles of the involucres

hardened and frequently more or less united at the base, the inner ones often broad and scale-like. In some specimens, however, of *C. calyculatus*, Cav., and its allies the hardening appears so slight as to bring the genus into very close connexion with *Pennisetum*.

13. Pennisetum, Pers., the principal genus of the group, would now contain about forty species, chiefly African, amongst which two or three extend to the Mediterranean region, tropical or central Asia, or tropical America, and a very few may be endemic in Asia, Australia, or America. It has been at various times proposed to separate several genera from it, and two or three of these have been pretty generally adopted; but they pass so gradually one into the other, and their chief characters, derived from the hairiness or numbers of the involucral bristles, are so little in accord with any other characters or habit, that the several following groups can scarcely be considered even as definite sections. *Pennisetum* itself has been restricted to those species in which the bristles are numerous and some or all of them more or less hairy; whilst those in which the whole of the bristles are perfectly glabrous form the genus *Gymnotrix*, Beauv. But however easy this distinction may appear at first sight, it is neither natural nor always definite. In a few African species proposed by Figari and De Notaris as their genus *Eriochæte*, the whole of the setæ are densely woolly-plumose; in some of the commoner species numerous outer setæ of each involucre are glabrous, and as many or more or fewer of the inner ones are hairy. In *P. flaccidum*, Munro, from East India, and *P. Benthamianum*, Steud., from tropical Africa, amongst very numerous glabrous ones there are generally only two or three hairy ones, or sometimes none at all, thus forming a gradual connexion with the true species of *Gymnotrix*, where the setæ are always quite glabrous; and there is nothing else whatever to distinguish the two series even as marked sections. *P. lanatum*, Klotzsch, is a remarkable Himalayan species, in which the involucral bristles are few, sometimes reduced to a single long rigid branched one, either plumose or glabrous, showing well the true nature of the involucre of the genus. *Penicillaria*, Willd., often still retained as a genus, was founded upon a plant frequently cultivated in the Indo-African regions, which may at first sight appear to be abundantly distinct. The long dense cylindrical spike or spike-like panicle is often above a foot long and an inch in diameter, although in other cultivated specimens not above

half that size. The involucres sometimes remain persistent after the spikelets have fallen away, and the filiform styles are remarkably long; but many cultivated specimens and some East-African ones, possibly wild, offer so much variety in these respects, some passing quite into normal *Penniseta*, that it seems probable that the peculiarities of habit have arisen from long cultivation. The long styles united at the base occur in other species, amongst which *P.* (*Gymnotrix*) *macrostachyum*, Brongn., has on that account been proposed by Hasskarl as a genus, under the name of *Sericura*. *Amphochæta* of Andersson is a Galapagos species of the *Gymnotrix* group, with small spikelets in slender pedunculate spikes, forming a loosely paniculate inflorescence, very different from that which characterizes the greater number of *Penniseta*, but closely connected with them through the several varieties of *P.* (*Gymnotrix*) *tristachyum*, Kunth. In *P.* (*Gymnotrix*) *unisetum*, Nees, an African species proposed as a genus by Figari and De Notaris under the name of *Beckeropsis*, this peculiar inflorescence is carried still further, and the involucre is sometimes reduced to a single bristle (always above the articulation and falling away with the spikelet), though I usually find 2, 3, or even more bristles. It is probable that the plant figured by Beauvois as *Setaria longiseta* is this same species of *Pennisetum*. Steudel's proposed genera *Catatherophora* and *Oxyanthe* are normal species of *Pennisetum* (*Gymnotrix*).

14. Plagiosetum, Benth., is a single Australian species, which I characterized as a genus chiefly from its peculiar inflorescence and habit, which prevented my retaining it in *Pennisetum* without an extension of the generic character beyond what I felt justified in proposing.

15. Paratheria, Griseb., is a single West-Indian species, which proves to be identical with the Brazilian plant since published by Doell as a section of *Leptachyrium* of *Panicum*, but which is evidently more nearly related to *Pennisetum*. The inflorescence is a simple spike-like panicle, of which the numerous short articulate branchlets or pedicels are continued beyond the single spikelets into long awns or bristles, which fall away with the spikelet like the involucres of *Pennisetum*, thus forming in some sort a connexion between the *Cenchrus* group of genera and the following one.

Our third or *Chamæraphis* group of Paniceæ consists of seven small genera, loosely connected by a character which may be con-

sidered as rather artificial than natural, but which I believe to be constant. The spikelets are nearly those of *Panicum*, but with the fruiting glume usually less hardened; the inflorescence is nearly that of the paspaloid *Panica* or of the Chlorideæ, but distinguished from the former by the rhachis of the partial spikes or fascicles or branches of the panicle being produced beyond the spikelets into a more or less rigid point. From Chlorideæ the articulation of the pedicel below the spikelet always separates the present group. The genera are:—16. ECHINOLÆNA, Desv., a single tropical American species (*E. scabra*), which has quite the rigid single spike of some Chlorideæ, but the spikelets of Paniceæ intermixed with barren ones, on which account Rudge originally figured the plant as a *Cenchrus*. The loosely paniculate species added to *Echinolæna* by Kunth have been rightly restored to *Panicum* by Trinius. 17. CHAMÆRAPHIS, Br., four Australian or tropical Asiatic species, fully described in my 'Flora Australiensis.' 18. SPARTINA, Schreb. (*Trachynotia*, Mich., *Limnetis*, Pers., *Ponceletia*, Thou., *Solenachne*, Steud.), five or six European, African, or American species, chiefly maritime, has been usually placed amongst Chlorideæ; but the spikelets themselves containing a single terminal flower, and the articulation of their pedicels, are quite those of Paniceæ, not of Chlorideæ. 19. XEROCHLOA, Br., three Australian species, 20. STENOTAPHRUM, Trin. (*Diastemanthe*, Steud.), two or three tropical maritime species, 21. PHYLLORHACHIS, Trimen, a single one from Angola, and 22. THUAREA, Pers. (*Ornithocephalochloa*, Kurz), also a single maritime species from the shores of the Indian and South-Pacific oceans, are all perfectly isolated genera whose peculiarities have been well pointed out. *Stenotaphrum* is the only genus I know in the tribe Paniceæ which has the rhachis of the inflorescence articulate; but this can usually not be perceived except in an advanced state, and has been denied by some botanists. I have already alluded (Journ. Linn. Soc., Bot. xvii. 196) to Kunth's mistake, which induced him to alter Persoon's name *Thuarea* (abridged from Thouars's then MS. name of *Microthuarea*) to *Thouarea*.

There remain seven very anomalous genera, but little connected with each other, and still less with any other genera of Gramineæ, but which have all more of the general character of Paniceæ than of any other tribe. They have all been well defined and illustrated, and require no more than a bare enumeration on the present occasion. They are:—23. SPINIFEX, Linn., three Austra-

lian species, of which one extends to New Zealand and New Caledonia, with a fourth from the coasts of tropical Asia closely allied to one of the Australian ones; 24. Olyra, Linn., about twenty species, of which one is tropical African, the remainder tropical American, including as a section *Lithachne*, Beauv. (*Strephium*, Schrad., *Raddia*, Bertol.); 25. Pharus, Linn., five American species; 26. Leptaspis, Br., three or four tropical species from Africa, Asia, or Australia, a genus nearly allied to, but perfectly distinct from, *Pharus*; 27. Lygeum, Linn., a single maritime species from the Mediterranean region; 28. Streptochæta, Schrad. (*Lepideilema*, Trin.), and 29. Anomochloa, Brongn., both single Brazilian species.

Tribe II. Maydeæ.

The grasses composing this tribe are usually erect and tall, with flat, long or broad leaves, the spikelets always unisexual, the males, in all except *Pariana*, in the upper part of the plant or of the inflorescences, the females at the base or in the lower axils, the grain, in all except *Zea*, enclosed in a hard stony case, formed variously of an outer glume or of a subtending bract. Where there are several fruiting spikelets in one inflorescence they are superposed, and each one falls away separately with the internode to which it is attached, the rhachis of the spike disarticulating at each node. The male spikelets either wither away or remain persistent above at the end of the stem or on the top of the uppermost fruiting spikelet. The tribe is thus perfectly well defined and quite distinct from any other; and the eight following genera of which it is composed, all tropical or American, and mostly small or monotypic, are likewise marked by positive characters.

1. Pariana, Aubl., an American genus of about ten species, is in many respects anomalous. The females, as in the other genera, are single at each node of the articulate inflorescence; but the male spikelets, instead of forming a terminal panicle, surround the female at each node and fall away with it. The stamens are also indefinite in number, ten to twenty in the spikelets examined, but Nees found as many as forty; whilst in all the other genera of the tribe there are only the normal three. Doell describes the female flower as having five lodicules; but here there is probably a mistake. I have never been able to see more than three, which are rather large; but there are

sometimes within them two or three very minute scales, which may possibly be rudimentary staminodia. Doell has also proposed to separate generically, under the name of *Eremites*, a Brazilian plant which, from the single spike I have seen as well as from his description and figure, appears to be no more than a starved state of some true *Pariana*.

2. Coix, Linn. (*Lithagrostis*, Gærtn.), contains three or four East-Indian species closely allied to each other, one of which, the common "Job's tears," is widely spread over the warmer regions both of the New and the Old World, but in many places of comparatively modern introduction. The hard covering of the fruit here consists of the sheath of a subtending bract, the withered glumes as well as the internode of the rhachis remaining entirely enclosed within it.

3. Polytoca, Br. (*Cyathorhachis*, Nees), three or four tropical Asiatic species in which the stony case of the fruit is formed by the outer empty glume, which is completely closed over the remainder of the spikelet as well as the internode to which it is attached. The species are:—(1) *P. bracteata*, Br. (*Coix heteroclita*, Roxb.), spicis masculis terminalibus ramosis, inferioribus androgynis v. fœmineis plerisque simplicibus, glumis exaristatis: (2) *P. Wallichiana* (*Cyathorhachis Wallichiana*, Nees), spicis masculis terminalibus ramosis, inferioribus androgynis v. fœmineis plerisque simplicibus, spicularum mascularum gluma exteriore longe tenuiterque aristata: (3) *P. macrophylla*, sp. n., spicis longis (omnibus?) androgynis simplicibus, glumis acuminatis exaristatis; folia adsunt 2-pedalia, 2 poll. lata, spicæ 4–6-pollicares: from the Louisiade Archipelago (*MacGillivray*).

4. Chionachne, Br., contains three species from tropical Asia or Australia, in which the hardened fruit-case is formed, as in *Polytoca*, of the outer empty glume, but the internode of the rhachis, instead of being completely enclosed within it, is embraced only by its thickened margins, and is seen lying as it were in a groove of the fruit-case.

5. Sclerachne, Br., is a single Javan species, with the fruit nearly of *Chionachne*, but with a different habit, and the hardened outer glume is produced beyond the fruit into an open membranous appendage.

6. Tripsacum, Linn., consists of two or three American species with the terminal male inflorescence usually more branched than in the preceding Asiatic genera, approaching that of *Euchlæna*

and *Zea*; and the hardened fruit-case is formed partly only by the outer glume, and partly also by the broad thickened and hardened internode of the rhachis.

7. Euchlæna, Schrad. (*Reana*, Brign.), has, like *Zea*, the terminal male inflorescence paniculate with numerous spikelets, and the female spikes in the lower axils wrapped up in broad bracts, from which are protruded the long filiform styles; but, as in the preceding genera, the female spikelets are within each bract superposed in a single row on the articulate rhachis of the single spike. The affinity to *Zea* appears to be recognized in the country; for specimens have been received from Schaffner purporting to be known as "wild maize."

8. Zea, Linn. (*Mays*, Gærtn.).—This most important, widely diffused, and most striking grass is only known in a cultivated state, or perhaps as an escape from cultivation. With most of the general characters of the tribe to which it gives its name, it is exceptional not only in that tribe, but in the whole Order, by the manner in which its numerous female spikelets are densely packed in several vertical rows round a central spongy or corky axis. How far this arrangement may have gradually arisen after so many centuries of cultivation can only be a matter of conjecture. Its gradual progress cannot be traced through the numerous cultivated varieties, many of them described as species in Bonafous's splendidly illustrated monograph; and the idea that some of them are wild indigenous forms must be traced to the insufficiency of the observations recorded by travellers.

Tribe III. Oryzeæ.

This tribe, as originally constituted, was loosely characterized, chiefly by uniflorous spikelets and stamens more than three—a character more or less dispersed through various different tribes; and several of the genera included in it by Kunth have since been rejected. The close affinity of Oryzeæ and Phalareæ has also been recognized, though the limits of the latter tribe also have been very unsettled. In the 'Flora Australiensis' I had united the two as an intermediate tribe, connecting, as it were, the two great primary series of Panicaceæ and Poaceæ; but upon the whole it seems better to separate them as tribes technically distinct, but representative of each other in the two great series. The essential character of both resides in having the scale immediately under the single terminal perfect flower keeled or 1-nerved like the glumes, so as to

leave it uncertain whether it is a glume or a palea—that is, whether it be attached to the end of the rhachilla or primary axis of the spikelet, or to a secondary or floral axis reduced to a mere point. There are theoretical reasons in favour of both explanations, and actual observation is insufficient for determining the point. The first of these views has appeared to me the most plausible; and I have accordingly in my diagnoses and descriptions treated the scale in question as the flowering glume, and considered the palea as deficient, as it certainly is in some Andropogoneæ and Agrosteæ. In this view the technical distinction between the two tribes would be, that the Oryzeæ have 2, 4, or rarely 3 glumes, all above the articulation of the pedicel, and the Phalareæ 4, 6, or rarely 5 glumes, the lowest pair persistent below the articulation of the rhachilla. Oryzeæ thus characterized may be thought as a whole to be a rather artificial tribe; but they are divisible into two much more natural groups or subtribes—*Zizanieæ*, tropical or American genera, often semiaquatic plants, with a loose inflorescence and stamens often, but not always, more than three; and *Alopecureæ*, European or temperate Asiatic or African genera, with a dense spike-like inflorescence and stamens never more than three.

Zizanieæ includes the following eight genera:—

1. HYDROCHLOA, Beauv., a single species from Carolina, and there apparently rare, differing from *Zizania* chiefly in the inflorescence reduced to few-flowered spikes, of which the terminal one male and pedunculate, the lower ones female and sessile in the axils.

2. ZIZANIA, Linn., comprises two species, or according to others two genera, each with two or more species. As a whole, the genus is a natural one, well characterized by the unisexual spikelets in an androgynous panicle, each one with only two glumes and the males with six stamens. The typical *Z. aquatica*, Linn. (*Hydropyrum*, Link), has the lower part of the panicle more spreading and male, and the upper part narrow and female; it is widely spread over North America, and includes the East-Russian and Japanese *Z. latifolia*, which is absolutely identical with some North-American specimens. The other species, *Z. miliacea*, Kunth (*Zizaniopsis*, Doell), has the male and female spikelets more mixed in the panicle, the awns shorter, the styles more connate, and the grain broader—characters which appear to me quite insufficient for generic distinction. It is a North-American

plant, and possibly also South-American, if Sello's single specimen described by Trinius and figured by Doell as *Z. microstacyhs*, Nees, was really from South Brazil. I see nothing in the figure or description to distinguish it from *Z. miliacea*.

3. Luziola, Juss., has, like *Zizania*, unisexual spikelets with only two glumes; but the spikelets are smaller, not awned, the styles short and quite distinct, and there are usually more than six stamens in the males. Six species are known from tropical America or the southern States of North America. The relative arrangement of the males and females varies as in *Zizania*. In the typical *L. peruviana*, Juss. (*L. brasiliensis*, Moric.), in *L. alabamensis*, Chapm., and in an apparently unpublished Guiana species, both sexes are in terminal panicles, but on distinct stems. In *L. Spruceana*, Benth., described by Doell (figured by G. F. W. Meyer as *L. peruviana*, but not Jussieu's plant), the males are in a terminal panicle, whilst the females are in the lower axils of the same stem, as they are also said to be in *L. longivalvis*, Doell, a Brazilian plant which I have not seen. In the proposed genus *Caryochloa*, Trin. (*Arrozia*, Schrad.), also Brazilian, the males and females are in the same panicle, the former in the upper, the latter in the lower part. The stamens in this species appear also to be always six only, which only occasionally occurs in the others; but the other characters are entirely those of *Luziola*, to which I should unite the *Caryochloa* as *L. micrantha* (*Arrozia micrantha*, Schrad.).

4. Potamophila, Br., if we include in it *Maltebrunia*, Kunth, is a natural genus of three species, connecting in some measure *Zizania*, of which it has the habit, with *Oryza*, of which it has the small setaceous or acuminate outer glumes. In the typical *P. parviflora*, Br., from Australia, the spikelets are more or less polygamous, though the greater number appear to be hermaphrodite; in *P. leersioides* (*Maltebrunia leersioides*, Kunth) from Madagascar, and in *P. prehensilis* (*Maltebrunia prehensilis*, Nees) from South Africa, they are usually all, or nearly all, hermaphrodite. Kunth also distinguishes *Potamophila* from *Maltebrunia* as having two flowers to the spikelet, a character not mentioned by Brown and which I have been unable to verify. The spikelets figured by Kunth, Rev. Gram. t. 5. figs. 1, 2, & 5, must be very rare and probably abnormal; I have searched in vain for them both in Brown's and in Beckler's specimens.

5. Hygrorhiza, Nees (*Potamochloa*, Griff.), is a single East-

Indian semiaquatic species nearly allied to *Zizania*, but quite distinct in its hermaphrodite flowers and other characters.

6. Oryza, Linn. (*Padia*, Zoll. and Mor.), an Asiatic genus, of which the typical species, the well-known Rice, appears to be really indigenous in Australia as well as in East India; but it has been so much cultivated from time immemorial, that it is now found apparently wild in various parts of Africa and America. It has produced a large number of different forms, nearly twenty of which have been published as substantive species, all of which, or nearly all, are reduced by others to varieties of *O. sativa*. The Himalayan *O. coarctata*, Griff., appears, however, to have more positive characters; and possibly two or three others may be maintained as fairly established species.

7. Leersia, Swartz (*Homalocenchrus*, Mieg., *Ehrartia*, Wigg., *Asprella*, Schreb., *Blepharochloa*, Endl.), is essentially American; but the two commonest species—*L. hexandra* in tropical, *L. oryzoides* in more temperate regions—are widely spread also over the Old World, and had probably long been so before the civilized communication between the two continents. The genus is closely connected with the Asiatic *Oryza*; but, besides the apparent diversity in geographical origin, the smaller spikelets with thinner glumes and the general inflorescence give to *Leersia* a different aspect, and, in technical character, the want of the two small outer glumes may justify its retention as a distinct genus. It is true that those who unite it with *Oryza* maintain that these outer glumes are represented by a cartilaginous ring at the base of the spikelet; but this ring is often so slight as to be rather imaginary than real, and never more than what is observable in *Eriochloa* and some other Gramineæ, where no such theoretical explanation is wanted or attempted.

8. Achlæna, Griseb., is a single Cuban species, which the author compares with the Australian *Microlæna*; but the want of any glumes below the articulation places it in Oryzeæ, not in Phalarideæ. It is in some other respects allied to *Oryza* and *Leersia*; but the peculiar inflorescence, the form and proportion of the glumes, &c. readily distinguish it. Grisebach found only a single stamen in the flower, a character which I have no means of testing, the spikelets in our specimens having already lost their stamens.

The Alopecuroid group of Oryzeæ consists of four genera:—

9. Beckera, Fresen., two or three Abyssinian species, in some

respects intermediate between the two groups. The structure of the spikelets, with the two outer glumes very minute or deficient, connects them with the preceding genera; whilst the spicate inflorescence and three stamens are nearer those of *Alopecurus*, although the spikes are much more slender and several on the same stem, on long slender peduncles. The genus is confined to those of the § *a* of Steudel's 'Synopsis;' the species arranged under § *b* have a very different structure, and form the section *Beckeropsis* of *Pennisetum*.

10. Crypsis, Ait. (*Antitragus*, Gærtn.), must be limited to the original *C. aculeata*, which alone has the characters of the tribe. All the other species usually referred to it have the 2-nerved palea and other characters of the Agrosteæ, and were well separated by Host under the name of *Heleochloa*. It is true that some short-spiked varieties of *Heleochloa schœnoides* have very much of the aspect of *C. aculeata*; but besides the structure of the spikelets and the articulation of the rhachilla, they are readily distinguished by the rhachis of the spike, which is linear and cylindrical, not flat as in *Crypsis*.

11. Cornucopiæ, Linn., is a single Oriental species, very near *Crypsis*, but well characterized by the peculiar inflorescence and by the form of the fruiting spike and peduncle, which has supplied the generic name.

12. Alopecurus, Linn., including *Colobachne*, Beauv., and *Tozzettia*, Savi, is a well-known and perfectly definite European and temperate Asiatic genus, with the habit nearly of *Phleum* and the structure of the spikelets that of Oryzeæ. Above forty supposed species have been enumerated; but at least half of them must be regarded as trifling varieties of the two or three commonest species, which have now, and perhaps from remote times, spread over a great part of the civilized world.

Tribe IV. Tristegineæ.

This tribe, first proposed by Nees, has been fully adopted and much extended by Munro, and now consists of thirteen genera, which had been variously scattered in Paniceæ, Andropogoneæ, and Agrosteæ, and are really more or less connected with the three tribes. They differ from Paniceæ and approach Andropogoneæ in the thin, often hyaline texture of the fruiting glume and palea, and by the frequent presence of a slender, often bent awn on the flowering glume. From Andropogoneæ they are chiefly separated

by their inflorescence; the spikelets are singly scattered or clustered along the inarticulate branches of the panicle or, in the very few cases where they are in pairs, the two of each pair are perfectly similar. Tristegineæ are distinguished from Agrosteæ by the characters which separate the two primary series Panicaceæ and Poaceæ. The tribual name was given by Nees from the genus *Melinis*, which he published as *Tristegis*, believing it to be new; and although its identity with Beauvois's *Melinis* has since been established, it does not seem worth while now to alter the tribual name, which has been pretty generally adopted. Of the thirteen following genera, several of them common to the New and the Old World, the first four, with three glumes to each spikelet, are temperate or subtropical, the following nine all tropical, with four glumes to the spikelet.

1. THURBERIA is a new name I have been compelled to substitute for *Greenia* of Nuttall or *Sclerachne* of Torrey, both of which had been preoccupied. The genus is limited to two North-American species which Steudel has proposed to unite with *Limnas*; but they differ essentially from it in the awn of the flowering glume terminal, not dorsal, in the distinct styles, and other characters besides habit. I have named the genus after G. Thurber, who has much studied North-American Gramineæ and worked them up for S. Watson's Californian Flora. The genus formerly dedicated to him by Asa Gray has since proved not to be distinct from *Gossypium*, to which it has been reunited by the author himself.

2. LIMNAS is a single perfectly distinct species from East-Russian Asia, well described and figured by Trinius.

3. POLYPOGON, Desf., a genus readily known by its dense inflorescence and the long awns of its empty glumes, is one of those which interferes in some measure with general classification. It has usually been placed in Agrosteæ; but the very decided articulation of the pedicel removes it from that tribe to the Tristegineæ, where in many respects it is allied to *Garnotia*. It consists of about ten species, dispersed over the temperate regions both of the northern and the southern hemisphere, one of them almost cosmopolitan, but they are rare within the tropics. It was first published by Savi under the name of *Santia* in the Memoirs of the Italian Society of Science, a publication which had so little circulation that the name has not found its way into standard works, and that of Desfontaines has now been so long and so generally in use in all countries, that it would only create useless confusion now to

take up Savi's. The Mexican *P. elongatus*, H. B. K., which is Presl's genus *Nowodworskya* (first described and figured by him under the name of *Raspailia*), has the pedicels, although clavate as in the rest of the genus, yet less decidedly articulate, thus forming some real connexion with the Agrosteæ.

4. Garnotia, Brongn. (*Miquelia*, Nees, *Berghausia*, Endl.), which sometimes comes near to some forms of *Polypogon*, has, on the other hand, the spikelets in pairs on the inarticulate branches of the panicle as in *Miscanthus*, and thus very closely connects Tristegineæ with Andropogoneæ. It has, however, none of the long hairs on the rhachilla so common in Andropogoneæ, and cannot well be removed far from *Arundinella*, whilst *Miscanthus* is too near to *Imperata* to be rejected from Andropogoneæ. *Garnotia* comprises about eight species from East India, China, and Japan.

5. Arundinella, Raddi, includes *Goldbachia*, Trin., *Acratherum*, Link, *Thysanachne*, Presl, and *Brandtia*, Kunth. It is the principal genus of the tribe, and comprises about twenty-four species spread over the tropical regions both of the New and the Old World, but chiefly in Asia. It is generally adopted and fairly characterized, though the habit and especially the inflorescence vary much, the panicle being sometimes long, narrow, and dense, or very large, loose, and spreading, with very numerous small or minute spikelets, whilst in a few species it is short and dense, forming almost an oval head with larger spikelets. The two sections proposed by Nees—*Meliosaccharum*, with a small tooth on the flowering glume on each side of the awn, and *Acratherum*, in which the glume is quite entire, tapering into the awn—do not prove to be well defined nor conformable to habit. *A. flammida*, Trin., from Brazil and tropical Africa, has neither the habit nor the character of the genus, but is in every respect a *Trichopteryx*, with which it was not compared by Nees, Trinius, or Doell, because it was at first only known as Brazilian, and *Trichopteryx* was supposed to be exclusively African.

6. Phænosperma, Munro, is a single Chinese species, nearly allied to *Arundinella*; but there are three lodicules to the flower and no palea (unless one of the lodicules, although apparently in the same whorl as the others, be really a small palea), and the caryopsis is half exserted from the fruiting glumes as in some species of *Sporobolus*. *Phænosperma globosa*, Munro, is a tall grass with a very large loose panicle, the slender but rigid

branches distantly verticillate along the main rhachis. It was first received from the Jardin des Plantes at Paris, where it had been raised from seeds brought from China by the Père David; but it has since turned up among Shearer's Kiu-Kiang plants.

7. Melinis, Beauv. (*Tristegis*, Nees, *Suardia*, Schrank), is a single Brazilian species, Nees's original type of the tribe. It is very near *Arundinella*, but remarkable for the long slender awn of the third empty glume, whilst the flowering glume is short, without any awn. Doell has reduced the genus to a section of *Panicum*, a view in which I can by no means concur.

8. Triscenia, Griseb., is a single Cuban species unknown to me, but from the author's description it must be very near to the following. 9. Arthropogon, Nees, a single Brazilian species, well described and figured by Kunth. So also is 10. Reynaudia, Kunth, a single West-Indian species allied to *Arthropogon*; but the awn, longest on the lowest glume, is gradually shortened and reduced to a point on the flowering one, and there is no palea: there are, however, four lodicules, a condition so unusual in Gramineæ, that we might be tempted to consider the lowest pair of lodicules, though close upon the others, as being in fact a bipartite palea.

11. Rhynchelytrum, Hochst., two or three tropical African species, which appear to form a fairly distinct genus allied to *Arundinella*, but approaching nearer to the Andropogoneæ in the long hairs of the lower glumes. The generic name was originally Nees's, who applied it to a South-African plant of Drège's, which proves to be scarcely even a variety of the *Panicum* (*Tricholæna*) *roseum* of that country. Hochstetter and Steudel totally misunderstood Nees's genus when they added to it their *R. grandiflorum* and *R. ruficomum*, which may now, however, retain those names, Nees's genus being suppressed.

12. Thysanolæna, Nees (*Myriachæta*, Zoll. and Mor.), is a single tropical Asiatic species, a very tall grass with long broad leaves and a very large full panicle, with innumerable minute spikelets in dense clusters along its long crowded branches. The flowering glumes are more or less covered with rather long hairs; but these hairs are so closely appressed and covered by the empty glumes that Steudel could not see them, and published a supposed second species as being destitute of them. Trinius figured the plant as a *Panicum*; by other early Indian botanists it was referred to *Agrostis*.

13. Cleistachne, is a genus I have proposed for two plants, one from East India, the other from tropical Africa, which have something of the aspect of *Sorghum tropicum*; but the spikelets all hermaphrodite, and never in pairs, remove them from the Andropogoneæ to the Tristegineæ. I purpose figuring the genus in the forthcoming part of Hooker's Icones.

Tribe V. Zoysieæ.

I have composed this tribe of two groups or subtribes, which might perhaps have been regarded as separate tribes, although the difference between the two is only that which lies between the *Cenchrus* group and Paniceæ proper. In the first group, *Anthephoreæ*, the spikelets disarticulate from the rhachis of the inflorescence or from the pedicels in little clusters of two to six, or very rarely more; in the other group, or *Zoysieæ proper*, the spikelets are solitary, or very rarely two together on the pedicels. In both groups the structure of the spikelets is generally that of Andropogoneæ, sometimes slightly approaching that of Paniceæ, but the pedicels are singly scattered or alternate along the inarticulate rhachis of the spike or general inflorescence. The Anthephoreæ have hitherto been usually placed in Paniceæ, as having nearly the inflorescence of *Cenchrus*, but of which they have not the hardened inner fruiting glume; the Zoysieæ proper have mostly been considered as Andropogoneæ, from which they differ in inflorescence. Of the twelve following genera, the first six belong to Anthephoreæ, the remaining six to Euzoysieæ or Zoysieæ proper.

1. Hilaria, H. B. K., in which I should include *Pleuraphis* of Torrey, and, judging from the figure and description, *Hexarrhena* of Presl, comprises five or six species dispersed over the Mexicano-Texan region, extending into California. Although the forms and proportions of the glumes of each spikelet vary much in the different species, or even in different spikes of the same plant, the genus as a whole is a natural one, and readily recognized by each cluster consisting of three spikelets, the central one containing a single fertile flower, either female or hermaphrodite, the two lateral ones each with two male flowers. The spikelets are often so closely sessile in the cluster, that it requires some care to ascertain which glumes belong to each cluster, and the pairs of male triandrous flowers of the lateral spikelets have sometimes been described as single hexandrous flowers. The species I have

seen are *H. cenchroides*, H. B. K., *H. Jamesii* (*Pleuraphis Jamesii*, Torr.), *H. mutica* (*Pleuraphis mutica*, Buckl.), *H. sericea* (*Pleuraphis sericea*, Nutt.), and a West-Texan species (*Wright* n. 758 and 2109, *Berlandier* n. 168, 1428) very near *H. cenchroides*, but apparently distinct.

2. ÆGOPOGON, Humb. and Bonpl. (*Hymenothecium*, Lag., *Schellingia*, Steud.), extends in two species from Bolivia to Mexico. The genus has at first sight much the aspect of the Asiatic *Melanocenchrus*, or of some of the very short-spiked species of *Bouteloua*, but the real affinity appears to be with *Hilaria*. The spikelets usually vary from two to six in the cluster, mostly with one hermaphrodite flower in each, though there are usually one or two empty barren spikelets intermixed; the clusters are in a loose one-sided spike, each one very readily disarticulating from its very short pedicel.

3. CATHESTECHUS of Presl, a single Mexican species, is only known to me from his figure and description, which do not agree with each other in some important particulars. He says that the genus is allied to *Ægopogon*. I have no means of judging whether that be really the case.

4. ANTHEPHORA, Schreb., is a very well-known and perfectly characterized genus of five or six species, of which one is tropical American, the others tropical or Southern African. *Hypudæurus*, Hochst., quoted by A. Braun in 'Flora,' 1841, p. 275, and by some others, is *Anthephora abissynica*, Steud.

5. TRACHYS, Pers., is a single well-known species from the East-Indian peninsula, several times figured by the earlier botanists of this century. It is slightly anomalous in the tribe by its spikes being two together at the apex of the peduncle, and, as in *Anthephora*, the excessive hardness of the clusters of spikelets after flowering renders it difficult to trace their structure unless examined young. The name *Trachys* was changed by Reichenbach to *Trachyozus*, and by Dietrich to *Trachystachys*, as having been preoccupied by zoologists, a plea not now regarded as sufficient.

6. TRAGUS, Hall. (*Lappago*, Schreb.), is a single annual very well known as a common weed in tropical and temperate regions almost all over the civilized world.

7. LATIPES, Kunth, is a single tropical-African annual, extending eastward as far as Scinde, very well described and figured by Kunth. It has been united by others with *Tragus*; but the small spikelets, usually solitary or rarely two together on the

pedicel, and the very different shape and proportion of the glumes, seem sufficient to maintain the genus as distinct.

8. LOPHOLEPIS, Dcne., is a little slender East-Indian annual, allied in some respects to *Latipes*, but with excessively minute curiously shaped spikelets, so rapidly ripening and so very deciduous that it is very rare to find any on the specimens in an examinable state. The plant was first sent home by Wallich under the name of *Holboellia*, and was figured as such by Hooker in the Botanical Magazine; but in the meantime Wallich published a Lardizabalous genus under that name in his Tentamen of a Nepal Flora, and Decaisne therefore changed that of the present grass to *Lopholepis*.

9. NEURACHNE, R. Br., three Australian species, and 10. PEROTIS, Ait. (*Xystidium*, Trin.), from the tropical regions of the Old World, of which the species are variously estimated as from two to seven, are both of them well-known genera, accurately described and figured.

11. LEPTOTHRIUM, Kunth, founded on a specimen brought by Humboldt from tropical America, is unknown to me. It is said to be very near the Asiatic genus *Zoysia*, and, from the description, seems to differ chiefly in its widely distant geographical station and in the presence of an additional lower empty glume.

12. ZOYSIA, Willd. (*Matrella*, Pers.), is a well-defined genus of two or three maritime plants, dispersed over the shores of eastern and southern Asia, Australia, and New Zealand, extending also to the Mascarene Islands.

To these Zoysieæ I have provisionally added a small Mexican plant, the affinities of which are very puzzling, and which I have described and figured as a new genus SCHAFFNERA, so named after the collector from whom we have received it. At first sight it seemed to bear some resemblance to Presl's figure of *Cathestechus*; but the structure of the spikelets is quite different, being nearly that of *Zoysia*, whilst the general inflorescence, though on a much smaller scale, approaches that of some species of *Andropogon* (*Cymbopogon*) or of *Apluda*.

Tribe VI. ANDROPOGONEÆ.

This tribe is chiefly characterized by the spikelets in pairs at each node of the articulate rhachis of the spike or of the branches of the panicle, or in triplets at the end of each branch, and by the inner glume under the fertile flower being much smaller and

thinner than the lower or outer empty ones, usually hyaline, and often bearing a twisted or bent awn. The two spikelets of each pair are either both of them perfect and fertile, or one of them is male only or imperfect, or even quite rudimentary, and the spikelets are often more or less surrounded by long silky hairs. But to each of these characters there are exceptions in single genera, which are retained in Andropogoneæ as agreeing with them in most other respects.

The plants of this tribe are for the most part tropical or subtropical, although a few are found in more temperate regions, chiefly in the northern hemisphere. More than eighty genera have at different times been proposed, which some botanists would reduce to below twenty. Following as nearly as possible the principles we have hitherto adopted, I have thought that the following twenty-six may be admitted as fairly characterized, referring them to four subordinate groups or subtribes—*Sacchareæ*, *Arthraxeæ*, *Rottboellieæ*, and *Andropogoneæ* proper.

Sacchareæ comprise seven genera, in which the two spikelets of each pair are homogamous, both of them hermaphrodite and usually fertile, and the inflorescence paniculate, excepting *Pogonatherum*.

1. Imperata, Cyr., three or four species widely spread over the tropical and subtropical regions both of the New and the Old World, extending northwards to South Europe, China, and Japan. In this and the following, *Miscanthus*, the branches of the panicle are exceptionally inarticulate, showing an approach to the Tristegineæ; but the long silky hairs and the very much reduced hyaline flowering glume and palea retain them in Andropogoneæ. Munro has shown that the common American *I. caudata*, Anders., is identical with the Old-World *I. ramosa*, Anders.; and I also can find no difference between the two, any more than between the American and the Old-World specimens of *I. arundinacea*. Fournier has, however, proposed to separate the American forms of the two species generically under the name of *Syllepis*, on the plea of their having the two lodicules connate into a single large truncate one, which I have in vain sought for in several different American specimens. It is possible that Fournier may have considered the small truncate palea as a pair of united lodicules, but, if so, they are precisely the same in the Old-World species.

2. Miscanthus, Anders., as now limited, is a genus of eight species, of which one is South-African, the others dispersed over

Eastern Asia from the Malayan archipelago to Japan. It has the inarticulate panicle-branches and most other characters of *Imperata*, from which Andersson technically separated it by the awn of the flowering glume. Exceptional unawned species occur in so many genera where they are usually awned, that this can scarcely be regarded as a generic character where there is nothing else to separate the two forms. Here, however, if we remove one species from *Imperata* to *Miscanthus*, inflorescence supplies two natural groups. In *Imperata* the panicle is long, narrow, and dense, with short erect branches buried in the copious silky hairs, the glumes are never awned, and there is only one, or rarely two, stamens; in *Miscanthus* the panicle is loose, with long spreading branches, the silky hairs are less dense and in one species almost wanting, the flowering glume is in most species awned, and there are always three stamens. The species known to Trinius were by him included in *Eulalia*; and Munro, whom I followed in the 'Flora Hongkongensis,' restricted the name *Eulalia* to the species now constituting *Miscanthus*; but as the true *Eulalia* of Kunth is the type of a section of the very different genus *Pollinia*, I have thought it necessary to adopt Andersson's later name *Miscanthus*. Besides his species, I would include in the genus *M. fuscus* (*Eriochrysis fusca*, Trin., *E. attenuata*, Nees) from East India, *M. saccharifer* (*Imperata saccharifera*, Anders.), from North China, which has the inflorescence and stamens, but not the awns, of the other species, and *M. cotulifera* (*Eulalia cotulifera*, Munro) from Japan, which has scarcely any of the hairs of the other species. Steudel proposed the latter as a distinct genus under the name of *Eccoilopus*.

With 3. Saccharum and 4. Erianthus commence the series of true Andropogoneæ with the branches of the panicle articulate; and these two genera are so closely connected that they might well be reunited, although they are now almost universally recognized as distinct. There might indeed be no great objection to consider both, as well as *Pollinia* and *Spodiopogon*, as sections of one large genus. As now limited, *Saccharum* is chiefly characterized by the compound panicle, usually dense, sometimes very large, and the spikelets very small without any points or awns to the glumes. The species are supposed to be about ten, the typical ones belonging to the tropical or subtropical regions of the Old World, amongst which the well-known sugar-cane is now extensively cultivated also in America. The genus would also

include *S. Nareya* (*Eriochrysis Nareya*, Nees) and *S. longifolia*, Munro (*Eriochrysis longifolia*, Munro), from East India, *S. pallida* (*Eriochrysis pallida*, Munro) from South Africa, and *S. cayennense*, the typical *Eriochrysis* of Beauvois, which last differs only in the very dense almost spike-like panicle.

4. Erianthus, Mich. (*Ripidium*, Trin.), would be a more satisfactory genus if it could be restricted to the two old species *E. saccharoides*, Mich., from North America, and *E. Ravennæ*, Beauv., from the Old World; but besides the above-mentioned connexion with *Saccharum*, there are several South-American species which run very closely into *Pollinia*. On the whole, it seems best to consider *Erianthus* as an intermediate genus between *Saccharum* and *Pollinia*, having the inflorescence of the former, but the flowering-glume more developed into a point or awn almost as in *Pollinia*. It would then consist of about twelve species, amongst which *E. stricta*, Nees, from North America, has no hairs on the rhachilla, but only a short pubescence on the glumes.

5. Spodiopogon, Trin., differs from *Pollinia*, as *Chrysopogon* does from *Andropogon*, chiefly in inflorescence. The short branches of the panicle bear three spikelets, one sessile between two pedicellate, and occasionally there is a pair of spikelets below the three terminal ones; but the branches never form the regular spikes of *Pollinia*. Besides the original *S. sibiricus*, Trin., we have two additional species, *S. pogonanthus*, Boiss., from the Levant, and *S. albidus* (*Andropogon albidus*, Wall. Cat. Herb. Ind. n. 8821), from East India. The generic name has also been often misapplied. *S. angustifolius*, Trin., is a *Pollinia*; some others of his species with 2-flowered spikelets belong to *Ischæmum*. Fournier's Mexican *Spodiopogons* are evidently species of *Erianthus*; his *S. foliata* indeed (Bourgeau, n. 2979) appears to me to be identical with the original *E. saccharoides*, Mich.

6. Pollinia, Trin., is now a genus of about twenty-five tropical or subtropical Old-World species, with the inflorescence of the section *Gymnandropogon* of *Andropogon*, and the homogamous spikelets of *Saccharum* and *Erianthus*; the spikelets are in pairs along the simple branches of the panicle; these branches either few, almost digitate at the end of the peduncle, or more numerous and scattered along the main rhachis. The genus is divisible into two very natural sections:—1. *Eulalia*, with the spikes and pedicels covered with long silky or rufous hairs as in *Erianthus*, includes

P. aurea, Benth. (the original genus *Eulalia*, Kunth), *P. articulata*, Trin. (*Pogonatherum contortum*, Brongn.), *P. eriopoda*, Hance (*Spodiopogon angustifolius*, Trin.), *P. longisetus* (*Erianthus longisetus*, Anders.), *P. versicolor* (*Erianthus versicolor*, Nees), *P. filifolius* (*Erianthus filifolius*, Nees), and a few others. 2. *Leptatherum*, with slender spike-like branches, of which the hairs are few or short, so as to appear sometimes quite glabrous; this section includes *P. glabrata*, Trin. (*Eulalia glabrata*, Brongn.), *P. nuda*, Trin. (*P. imberbis*, Nees), *P. Willdenowianum* (the genus *Microstegium*, Nees, *P. lancea*, Nees, published also by Nees as his genus *Leptatherum*, and probably also Steudel's *Nemastachys*). Sprengel's *Pollinia* would have had the right of priority over Trinius's; but that proved a farrago made up of a few heterogenous species of *Andropogon*, *Chrysopogon*, and *Pollinia*.

7. Pogonatherum, Beauv. (*Homoplitis*, Trin.), is a single tropical and subtropical Asiatic species, very well marked by its slender, much branched habit, the single spikes, and the slender awns arising as well from the second empty glume as from the flowering one.

The *Arthraxeæ*, or second group of Andropogoneæ, consist of three genera, which have the inflorescence of *Pollinia*; but the second spikelet of each pair is generally reduced to a bare stipes, or is even quite deficient, bringing a few species very near to the Zoysieæ, differing chiefly in their subdigitate spikes, whilst a few others, in which the spikes are single, have the rudiment of the second spikelet of true Andropogoneæ.

8. Apocopis, Nees (*Amblyachyrum*, Hochst.), has five or six species from East India or the Malayan archipelago, characterized by the very broad truncate outer glume enclosing the rest of the spikelet. Among the species *A. Royleanus*, Nees (*Ischæmum paleaceum*, Trin., *Andropogon paleaceum* and *A. himalayensis*, Steud.), is remarkable for the awn often (but not always) reduced to a small fine point, or even entirely wanting; and *A. tridentata* (*Andropogon tridentatus*, Royle) has, on the contrary, a very long awn, and the young spikes are usually enclosed in a large spathe-like bract.

9. Dimeria, R. Br. (*Haplachne*, Presl, *Didactylon*, Zoll. and Mor., *Psilostachys*, Steud., *Pterygostachyum*, Nees), about ten species from the Indo-Australian region, has very slender spikes, the lower empty glumes very narrow and rather rigid, and usually, if not always, only two stamens.

10. Arthraxon, Beauv. (*Pleuroplitis*, Trin., *Batratherum*, Nees, *Lucæa*, Kunth, *Lasiolytrum*, Steud., *Alectoridia*, A. Rich., *Psilopogon*, Hochst.), has also about ten species, chiefly from the Indo-Australian region, but extending on the one hand to China and Japan, and on the other to tropical Africa. The spikes are slender as in *Dimeria*; but there are three stamens, and the lower empty glume is broad but acute, not truncate as in *Apocopis*.

Rottboellieæ, the third group of Andropogoneæ, is often regarded as a distinct tribe, characterized by the simple spike, the spikelets in pairs at each notch or excavation of the rhachis, the one sessile, the other pedicellate, and no awn to the flowering-glume. There are, however, as in other subtribes, here and there exceptions to one or more of these characters. We have seven genera.

11. Elionurus, Humb. and Bonpl., has about twelve species, chiefly South-American or African, with, however, one Australian and one from the East-Mediterranean region. They all differ little from *Rottboellia* besides the long silky hairs which clothe the spike, thus connecting Rottboellieæ with other Andropogoneæ. *E. hirsuta*, Munro (*Rottboellia hirsuta*, Vahl), has been proposed by Boissier as a distinct genus *Lasiurus*, as having the spikelets in threes instead of in twos at each node of the rhachis. But that character is by no means constant; in several specimens I have found the spikelets in threes or even in fours at the lower nodes; but in others they are in the normal pairs from the base of the spike.

12. Rottboellia, Linn. f., a tropical or subtropical genus widely spread, but chiefly in the Old World, has been either extended to nearly the whole subtribe or very variously restricted to a small number or to a single species. It seems best characterized by including all those which have the simple terete spike, without the hairs of *Elionurus* or the peculiarities of the four following genera. It would contain about eighteen species, amongst which several have been proposed as monotypic genera. *Cœlorhachis*, Brongn., is *R. muricata*, Retz (*R. glandulosa*, Trin.); *Peltophorus*, Desv., is *R. myurus*: in both of these the lowest or outer glume of the perfect spikelet is rigid and bordered on each side at the apex by a membranous wing, which, however, is also present, but much less prominent, in *R. rugosa*, Nutt. *Phacelura*, Griseb. (*Pholiurus*, Trin. in Spreng. Neue Entd. ii. 67, not of the Fundam. Agrost.), is the Oriental *R. digi-

tata, Sibth. (*R. Sandorii*, Friwaldsk.), a species striking for the long spikes, occasionally though very rarely branched at the base, and from the rather large spikelets with acuminate outer glumes showing an approach to some *Vossiæ*, but scarcely sufficiently distinct from *Rottboellia* to be kept up as an independent genus. *Cymbachne*, Retz, a Bengal grass, has been referred by Willdenow to *Rottboellia*. Retz's character does not quite agree; but the plant has not since been identified, and must remain doubtful. *Apogonia*, Fourn., comprises two Mexican species which I am unable to distinguish from *Rottboellia*: Nuttall's section *Apogonia* of *Rottboellia* is a species of *Elionurus*, very closely allied to, if not a variety of, *E. ciliaris*, H. B. K.

13. Ophiurus. This genus, as first proposed by Gærtner, included two very different plants separated by Brown as *Lepturus* and *Ophiurus*. As the latter is now limited, it differs from *Rottboellia* only in the absence of the second sterile spikelet of each node, at least in the upper part of the spike or inflorescence. It consists of three, or perhaps four, Asiatic, African, or Australian species:—*O. corymbosa*, Gærtn. (*O. æthiopica*, Steud.), *O. monostachya*, Presl (*O. undulata*, Nees), and *O. lævis* (*Rottboellia lævis*, Retz, *R. perforata*, Roxb.). The latter species is remarkable for having the spikelets in the lower part of the inflorescence in pairs at each node as in *Rottboellia*, but the two of each pair separated by a kind of partition dividing the cavity of the rhachis into two; it has therefore been raised to a genus by Kunth as *Mnesithea* and by Nees as *Thyridostachyum*. Generally, however, in the upper part, and sometimes in the whole inflorescence, the sterile spikelet is wanting, as in *Ophiurus*, especially in the young spike, for the upper or *Ophiurus* portion appears to fall away very readily, leaving only the *Mnesithea* part persistent. *Lepturus*, Br., is now classed in the tribe Hordeeæ.

14. Ratzeburgia, Kunth, a very elegant little flat-spiked Burmese grass, and 15. Manisuris, Linn., a common tropical weed with little globular spikelets, have both been well described and figured.

16. Hemarthria, Br., contains two or three tropical weeds or maritime grasses, separated from *Rottboellia* chiefly on account of the flattened and less distinctly articulated rhachis of the spike, and the curious way in which the stipes of the sterile spikelet is adnate to the rhachis, so as to make it appear sessile and almost opposite to a fertile spikelet, which really belongs to the next

superior node. These characters, though generally well marked, are sometimes more or less obscure.

17. VOSSIA, Wall. and Griff., closely connects the Rottboellieæ with *Ischæmum*. As in the former, the flowering glume is always unawned, and the rhachis of the spike is rigid and deeply notched, but the lower empty glume, at least of the pedicellate spikelet, is produced into a long point or awn; there are generally several spikes or simple branches along the common peduncle, and there is in each sessile spikelet a male flower below the terminal fertile one, as in *Ischæmum*. The genus was originally established on a handsome semiaquatic East-Indian grass, which has since been found also in tropical Africa, and two or three additional species have reached us from the same country. We should also refer to *Vossia* the *Ischæmum speciosum* of Nees from East India. *Eremochloa*, a Japanese plant described by Büse, is unknown to me; but the character given, if I correctly understand it, agrees well with that of *Vossia*.

To the fourth group, or subtribe *Euandropogoneæ*, may be referred nine genera, in which the two spikelets of each pair are heterogamous and the flowering glume of the fertile one is more or less awned; and in the first five the spikelets are in many pairs along the rhachis of the simple spikes or panicle-branches. These nine genera are increased to twenty-one by Andersson and others, whilst Steudel unites seven out of the nine under his *Andropogon*.

18. THELEPOGON, Roth (*Jardinia*, Steud.), comprises one East-Indian and two or three tropical-African species, all very elegant and closely resembling each other. Their inflorescence is that of *Vossia*, whilst the spikelets are nearer those of *Ischæmum*, but remarkable for the rigid tuberculate outer empty glumes. Nees, in working up Wight and Arnott's Peninsular grasses, gave Roth's name to a very different grass (*Ischæmum semisagittatum*, Roxb.), adding the observation that Roth's description is very bad. The fact is, however, that it is Nees who was mistaken in his identification, whilst Roth's description of the true plant is excellent.

19. ISCHÆMUM, Linn., as now understood, has about thirty species, widely dispersed over the warmer regions both of the New and the Old World, the chief character connecting them being that the sessile spikelets have a male flower below the terminal fertile one. The spikes are also usually stouter than in *Andropogon*, and the genus is a fairly natural one. Beauvois restricted it to the *I. muticum*, Linn., in which the awn of the flowering glume

is small and hair-like or sometimes entirely wanting, and proposed a genus *Meoschium*, adopted by Nees, for the other species in which the awn is more developed. Trinius considered as true *Ischæma* only those in which the pedicellate spikelet has only a male flower or empty glume, and added those in which that spikelet has two male flowers to his genus *Spodiopogon*, notwithstanding the difference in inflorescence &c. *Ischæmopogon*, Griseb., is *I. latifolium*, Kunth, and *Hologamium*, Nees, is *I. laxum*, Br., both species with two-flowered pedicellate spikelets, as is also the case in *I. insculptum*, Hochst., and *I. macrostachyum*, A. Rich., from tropical Africa, and probably also in Forskåhl's genus *Sehima*, of which we have no authentic specimen. *I. pectinatum*, Trin., *I. leersioides*, Munro, *I. ophiuroides*, Munro, with a fourth unpublished species, all from tropical Asia, form a distinct section (*Pectinaria*), with slender elegant simple spikes, and the larger glume of the sessile spikelets pectinate-ciliate.

20. Trachypogon, Nees, as limited by Andersson, and 21. Heteropogon, Pers., closely resemble each other in their simple spikes with appressed imbricate spikelets and long rigid twisted awns; but in *Trachypogon* the sessile spikelet of each pair is male or sterile and unawned, and the pedicellate one fertile and awned, whilst in *Heteropogon* the sessile one is fertile and awned, and the pedicellate one male or sterile and unawned. Andersson enumerates eleven species of *Trachypogon*, one from South Africa, the others from tropical or subtropical America; but several of the latter can scarcely be regarded as more than slight varieties. Of *Heteropogon* there are two well-marked species, *H. contortus*, Rœm. and Schult. (*H. hirtus*, Pers.), now very common in most warm regions and extending to the Mediterranean region and to North America, and *H. melanocarpus*, Ell. (*H. Roylei*, Nees, *H. acuminatus*, Trin., *Trachypogon scrobiculatus*, Nees), which is in North and South America as well as in East India. Besides these, three or four South-African species have been referred to *Heteropogon*, but are of somewhat doubtful affinity.

22. Andropogon, Linn., taking it within the limits assigned to it by Munro, including all the species of the subtribe with spike-like simple branches to the inflorescence, and without the peculiarities of the three preceding genera, is still a somewhat polymorphous genus of perhaps a hundred species, very abundant within the tropics, but well represented also in Europe, temperate Asia, North America, South Africa, and Australia. The fourteen

genera into which it has been divided may be fairly reduced to the following five, perhaps too artificial, sections:—1. *Schizachyrium*, about a dozen species, with the spikes always single upon each peduncle. The genus *Schizachyrium*, Nees, was limited to a few species in which the spike is slender and not very hairy. *Diectomis*, H. B. K., is the American *A. fastigiatus*, Sw., found also in tropical Africa, which has a more rigid spike and the second empty glume conspicuously awned. *Homœatherum*, Nees, is an Asiatic species scarcely to be distinguished from the same *A. fastigiatus*. In 2. *Cymbopogon*, the spikes, often very silky-hairy or woolly, are in pairs on each peduncle, and the peduncle partly or wholly enclosed in the sheath of a leafy or spathe-like bract. The species are numerous, chiefly in the Old World, and include the *lemon-grass* and its allies. Andersson has divided the section into two genera, *Gymnanthelia* and *Hyparrhenia*, and perhaps more; but as he has never published their characters, I am unable to form any clear idea of them. It would appear, however, from the species quoted, that *A. schœnanthus* and its allies would belong to *Gymnanthelia*, and *A. hirtus* and its allies to *Hyparrhenia*. 3. *Gymnandropogon*, has two or more spikes sessile at the end of the peduncle, without any sheathing-bract. The species are nearly as numerous as those of *Cymbopogon*. Amongst them, *A. annulatus*, Forsk., though closely allied to the common *A. Ischæmum*, forms the proposed genus *Dichanthium*, Willem.; *A. serratus*, Retz, with a broad herbaceous outer glume, is Trinius's genus *Lepeocercis*; and it is most probable that Steudel's *Euklastaxon* is the common American *A. virginicus*. 4. *Amphilophis*, Trin., would include *A. laguroides*, DC., and *A. argenteus*, DC., from tropical America, with *A. scandens*, Roxb., and *A. Vachellii*, Nees, from tropical Asia, and a few others, differing from *Gymnandropogon* in the more numerous, usually long and often pedicellate spikes, sometimes even divided at the base, forming almost a saccharoid panicle. 5. *Vetiveria*, Thou. (*Mandelorna*, Steud.), is the well-known *Vitiver*, *A. muricata*, Retz, to which Munro would redu e as varieties *A. nigritana*, Benth., and *Vetiveria arundinacea*, Griseb., a species frequent in East India and tropical Africa and introduced into America, distinguished by its numerous spikes verticillate along the axis of a long simple panicle, all glabrous or only minutely hairy, and the awn of the flowering glume often very much reduced. Beauvois's genus *Anatherum*, sometimes supposed to be specially destined for this plant, included also all the species

of the sections *Cymbopogon* and *Gymnandropogon*, in which the awn is much reduced or obsolete. *Agenium*, Nees, from his character, would also refer to one of these species without prominent awns.

23. Chrysopogon, Trin. (*Rhaphis*, Lour., *Centrophorum*, Trin.), and 24. Sorghum, Pers. (*Blumenbachia*, Koel.), are two genera very nearly allied to each other and differing from *Andropogon*, as *Spodiopogon* does from *Pollinia*, chiefly in their inflorescence; the branches of the panicle bear three spikelets at the end, a sessile one between two pedicellate ones, and occasionally only one or two pairs below on the same branch. They were both included by Linnæus, and afterwards by Brown, in *Holcus*, a name since restricted to that portion of the old genus which belongs to Avenaceæ. *Chrysopogon*, as now constituted, has nearly twenty species, chiefly tropical or subtropical, but including also the European *C. Gryllus* and some other temperate species. The genus may be divided into two natural sections: in the typical form the pedicellate spikelets usually contain a male flower; in the section *Stipoides*, exclusively American, it is reduced to a long hairy stipes rarely bearing a minute rudimentary glume. This section includes *C. nutans*, *C. avenaceus*, *C. stipoides*, *C. Minarum*, and a few others. *Sorghum* differs from *Chrysopogon* in habit, in the scarcely articulate branches of the panicle, and in the glumes of the fertile spikelets more hardened after flowering. The number of species is very uncertain, for, of the two principal ones, *S. halepense* is so widely spread as a tropical or subtropical weed, and *S. vulgare* so long and so generally cultivated in warm regions for a variety of purposes, as to have produced a great variety of forms, raised by many to the rank of species.

25. Anthistiria, Linn. fil. (*Themeda*, Forsk.), if taken as a whole, is a very natural genus, of about a dozen species from the warmer regions of the Old World, easily recognized by its inflorescence. The spikelets are in short dense spikes or clusters, usually seven together, of which the four lower ones (two pairs) are either empty or with a male flower in each, and are placed apparently in a whorl, forming a kind of involucre round the three inner ones, which, as in *Chrysopogon*, are one sessile between two pedicellate ones. In a few species the number of spikelets is raised to nine, or even to eleven, by the intervention of one or even two pairs of spikelets between the involucral and the terminal ones. These slight differences in the number or in the

pedicellation of the spikelets have induced the proposal of distinct genera for most of the species, and several of them have been adopted by Andersson in a monograph most carefully worked up in as far as the materials at his command admitted, but in which, for want of access to a sufficiently rich library, he is much mistaken as to several of the synonyms quoted. These proposed genera are:—1. *Aristaria*, Jungh., for *A. frondosa*, Br. (*A. Junghuhniana*, Nees), which forms the section *Heterelytron* of Andersson, but not Junghuhn's genus of that name. 2. *Perobachne*, Presl, is *A. arundinacea*, Roxb., forming Andersson's subsection *Chrysanthistiria*. 3. Andersson's subsection *Euanthistiria* for the common *A. ciliata*, Linn., and its immediate allies, to which some botanists would restrict the genus. Andersson distinguishes twelve species, adding at the same time that they might well all be reduced to varieties of a single widely-spread species. 4. *Androscepia*, Brongn. (*Heterelytron*, Jungh.), was founded originally on the *A. gigantea*, Cav., but became a very unnatural group when made to include *A.* (*Androscepia*) *anathera*, Anders., which very closely resembles *A.* (*Euanthistiria*) *minuta*, Anders., and a variety *armata*, Anders., of *A. gigantea*, which is much nearer to the *A.* (*Perobachne*) *arundinacea*. 5. *Iseilema*, Anders., containing two East-Indian and one Australian species, and 6. *Exotheca*, Anders., comprising *A. abyssinica*, Hochst., from tropical Africa, and *A. fasciculata*, Thw., from Ceylon, have each a peculiar habit and characters, sufficient to maintain them as sections. 7. *Germainia*, Balansa, has, perhaps, two closely allied species—*A. caudata*, Nees, from Khasiya and China, and the typical *A. capitata* fron Saigou; the latter, however, which I only know from Balansa's figure and description, is exactly like the Chinese plant, except that there appear to be rather more spikelets in the cluster.

26. Apluda, Linn., is now universally recognized as a distinct and natural genus, limited to the two tropical-Asiatic species originally assigned to it by Linnæus, though his character was even then very imperfect, and rendered still more so by the subsequent addition of the very different American *Zeugites*, which Schreber afterwards restored as an independent genus. Beauvois, however, threw every thing into confusion; for it is evident from his figures that his *Diectomis* is *A. aristata*, Linn., and his *Calamina* is *A. mutica*, Linn., though in drawing up his character for the latter he combined it with some species of *Anthistiria*. Beauvois's *Apluda* is certainly different, probably a *Chrysopogon*.

Series B. POACEÆ.

Having already explained the difference between the two primary divisions of Gramineæ, I need only repeat here that the main characters of Poaceæ consist, firstly, in the want of any articulation of the pedicel below the lower empty glumes, which remain persistent after the fruiting one has fallen away, or fall away separately, and, secondly, in the male or imperfect or rudimentary flowers, when present, being above, not below, the fertile one. The former character is all but universal; but from the latter one exceptions are not very rare, besides that, where there is only one flower without any continuation of the rhachilla beyond it, the character entirely fails. I should add that in some tribes of Poaceæ there are two or more perfect flowers in the spikelet, which is not the case in Panicaceæ; and may now proceed to examine in detail the eight tribes into which this second series may be divided.

Tribe VII. Phalarideæ.

The close affinity of this tribe and the Oryzeæ has been generally admitted, and the two are usually placed in juxtaposition; I had even proposed their consolidation into a single one in the 'Flora Australiensis.' They have in common the important character of the scale immediately under the single perfect terminal flower being keeled or one-nerved, so as to make it a matter of discussion whether it be a glume terminal on the main axis or rhachilla of the spikelet, or a palea at the base of a secondary floral axis. The deciduous part of the spikelet of Phalarideæ with its four glumes (or three glumes and a palea) is precisely as in Oryzeæ; but there are in addition, below the articulation, the two persistent empty glumes characteristic of Poaceæ. The spikelet, therefore, in this tribe consists of six glumes (or five and a palea), the lowest pair empty below the articulation; the second pair, above the articulation, corresponding to the lowest two glumes of Oryzeæ, are usually empty and small, sometimes reduced to a small bristle, rarely enclosing each a small palea or a male flower; the upper pair (or glume and similar palea) enclosing the terminal fertile flower and fruit, without any continuation of the rhachilla above it. A slight apparent exception will be mentioned under *Phalaris* itself; and in the genus *Cinna* of Agrostideæ and a very few Bambuseæ the palea of the fertile flower is, at least apparently,

one-nerved, but otherwise the character of Phalarideæ is constant. They comprise the following six genera:—

1. Ehrharta, Thunb. (*Trochera*, L. C. Rich.), has twenty-four species, of which two are from New Zealand, two from the Mascarene Islands, and all the rest from South Africa. In them the glumes of the second pair are the largest, empty and usually awned, and the fertile flower has six stamens. 2. Microlæna, Br., including *Diplax*, Hook. f., has five Australian or New-Zealand species, differing from *Ehrharta* only in the number of stamens reduced to four or two. 3. Tetrarrhena, Br., four Australian species, with four stamens to the flower as in *Microlæna*, but the glumes are in less regular pairs, all unawned, and the fourth (one of the second pair) alone the largest. The panicle is also almost always contracted into a spike, not, however, so dense and cylindrical as in the following two genera.

4. Phalaris, Linn., has nine or ten extratropical species, chiefly from the Mediterranean region, but also extending to North and South America. In this genus it is the lowest two persistent empty glumes that are the largest, usually very flat, and often winged on the keel, the second pair (like the lowest in *Oryza*) very narrow, sometimes reduced to small bristles, those of the upper pair thin and hyaline; and sometimes in both of them, but almost always in the uppermost one, the central nerve is very faint or quite obsolete, a character adduced as an argument that this upper one is a two-nerved palea on the floral axis, and not a glume on the main rhachilla. The two nerves are, however, very faint, and the central keel is usually marked by a line of hairs on the outside, and the question remains a moot one. In the majority of species the panicle is contracted into a dense globular or cylindrical head; but in *P. arundinacea*, Linn., a stout tall species, forming the genus *Digraphis*, Trin. (*Baldingera*, Gærtn., Meg., and Schrad., *Typhoides*, Mœnch), the inflorescence, though still very dense, is more or less branched or interrupted. This genus has also been supposed to be distinguished by the want of the broad wings of the outer glumes, so conspicuous in the common *P. canariensis*; but these wings are very narrow in *P. paradoxa*, Linn., and entirely disappear in *P. intermedia*, Bosc (*P. americana*, Ell.), leaving no available character to separate *Digraphis* generically.

5. Anthoxanthum, Linn., has four or five European species, of which one is now widely spread over various regions of the

globe, but often only as an introduced weed. One at least of the glumes of the lowest pair is the largest of the spikelet, as in *Phalaris*; those of the second pair, though small and without flowers, have a dorsal awn. The panicle is usually cylindrical and spikelike.

6. HIEROCHLOA, Gmel. (*Savastana*, Schrank, *Disarrenum*, Labill., *Torresia*, Ruiz and Pav.), about eight species from the colder or mountain regions both of the northern and the southern hemispheres, is usually referred to Avenaceæ next to *Holcus*; but it appears to me to be much nearer to *Anthoxanthum*, from which it differs in its looser paniculate inflorescence, and in the glumes of the second pair being but little smaller than the lower ones, and frequently, but not always, enclosing each a male flower. *Ataxia*, Br., one or two Asiatic and two South-African species, forms a section of *Hierochloa*, differing slightly from the typical form in the glumes of each pair being more unequal, the lower one only of the second pair (rarely both) having a male flower. *A. mexicana*, Rupr., seems to connect the two sections.

Tribe VIII. AGROSTEÆ.

The large tribe Agrosteæ is one of the most difficult to circumscribe satisfactorily, or to divide into definite genera. We have taken it nearly in the sense given to it by Trinius, so as to include the Stipeæ, of which other botanists make a distinct tribe; and we have adopted thirty-seven genera, a number which some would extend to above eighty, whilst others might reduce it to about thirty. Their general character is to have a single flower in each spikelet, either apparently terminal as in Panicaceæ, or with a slight bristle-like continuation of the rhachilla beyond it; and from these Panicaceæ they are constantly distinguished by the pair of empty glumes persistent below the articulation of the rhachilla, without any empty glume or male flower intervening between the articulation and the flowering glume. The single flower in the spikelet, which separates the tribe from the following ones, is not so positive a character, as it occurs also in one genus of Aveneæ, in a few genera of Chlorideæ, and occasionally in a few exceptional species of some genera of Festuceæ, which cannot well, from inflorescence or other accessory characters, be included in Agrosteæ. There are also two species of *Sporobolus* which approach the Isantheæ in having frequently two flowers; and in *Coleanthus* the lower empty glumes are entirely deficient.

Trinius, in his elaborate monograph of the tribe, divided it into three primary groups or subtribes—Vilfeæ with the callus scarcely prominent or quite obsolete, Agrosteæ with the callus globular, and Stipeæ with the callus obconical. In this I feel unable to follow him. In the first place he does not appear to have considered what the so-called callus really is. It is not, as the name would suggest, an appendage to the base of the flowering glume, or, as he would have termed it, to the flower, but only the upper or principal part of the rhachilla or axis of the spikelet, to which the glume and its enclosed flower are attached, and which breaks off immediately above the persistent empty glumes. Its shape depends on the distance at which the flowering glume is attached above the empty ones, a distance very variable throughout the Order. And although the long or the short interval may be more prevalent or even constant in some genera, yet I have never found the variations so precise as to be defined by actual measurement, and the species are numerous, even in *Stipa* itself, where it is doubtful whether we should call it long or short. It is sometimes a useful accessory character, but, I believe, never positive enough to be regarded as subtribual. It is true that no other simple absolute character has yet been proposed for the subdivision of the tribe; but we are obliged, here as elsewhere, to take a combination of characters, to each of which an occasional exception must be allowed. Acting on this principle, we might, whilst following in many respects the arrangements of Kunth and others, admit thirty-seven genera of Agrosteæ, distributed in four fairly natural subtribes, all four of wide geographical range, but chiefly in temperate regions, the tropical species mostly confined to mountain districts, and no genus, except a few monotypic ones, exclusively tropical.

Our first subtribe, STIPEÆ, is the long-established one of that name, slightly extended so as to include *Oryzopsis*, *Muehlenbergia*, and their immediate allies, the close connexion of which with *Stipa* has been frequently suggested. The subtribe thus formed would be characterized by the paniculate inflorescence not condensed into the cylindrical spike of Phleoideæ, by the rhachilla of the spikelet not produced beyond the flower except in the single species of *Brachyelytrum*, by the awn of the flowering glume terminal, not dorsal as in Euagrosteæ, and especially by the grain being very closely enveloped in the fruiting glume. In the majority of species these characters are well marked; but

in the larger genera there occur occasional exceptions more or less decided, which prevent our taking any single one of them as an absolute test. The subtribe would include the following eight genera, in the first five of which the fruiting glume is more or less hardened or rigid as in Paniceæ; in the succeeding three it is thinner, though still closely pressed on the grain.

1. Aristida, Linn., is now a genus of at least a hundred species, abundant in all the warmer regions of the globe, but also represented by a few species in Europe and temperate Asia, and by several in North America. With few exceptions it is most readily recognized by the long, fine, three-branched awns, the lateral branches opposite and spreading. Doell adds to the generic character three lodicules as in *Stipa*; and Nees describes three lodicules in some South-African species; but all other Agrostologists describe two only, and I have never found more than that number. It is probable that both Nees and Doell mistook for the third lodicule the palea, which in many species is very thin and scarcely, if at all, larger than the lodicules. The genus is divided into three fairly marked sections, which Beauvois, Nees, and some others have raised to the rank of genera. In (1) *Chætaria*, Beauv., the flowering glume is continuous with the awn without any articulation, and though much longer than the empty glumes, and often much attenuated at the end, is neither quite awn-like nor decidedly twisted below the branches. Amongst its species, *Curtopogon* was proposed as a genus by Beauvois for the North-American *A. dichotoma*, Mich., in which the lateral branches of the awn, instead of diverging from the central one, are short and erect at its sides, showing more or less distinctly that they are continuations of the lateral nerves of the glume. It is probable that this is the case throughout the genus, only that the lateral nerves before they diverge are so closely consolidated with the central one as to be undistinguishable from it. The genus *Ortachne* was proposed by Nees for two or three Mexican or Columbian plants, originally published by Kunth as species of *Streptachne*, Br., and afterwards transferred by him to *Aristida*, in which the lateral branches of the awn are very short, sometimes minute or even quite obsolete, thus nearly connecting the section *Chætaria* of *Aristida* with the section *Aristella* of *Stipa*, but in the narrow base of the rhachilla, and some other minor points, nearer to the former than to the latter. *Ortachne retorta*, Nees (in Steud. Gram.), is probably a true *Stipa*. In

(2) *Arthratherum*, Nees, the awn is decidedly articulate on the glume and much twisted above the articulation below the branches, the flowering glume itself much shorter than the lower empty glumes, instead of exceeding them as in *Chætaria*. In (3) *Stipagrostis*, Nees, the awn is articulate on the glume, as in *Arthratherum*, but scarcely twisted, and above the branches elegantly plumose, the branches also being plumose in some species; whilst in others, forming Figari and De Notaris's proposed genus *Schistachne*, the central awn alone is plumose, the lateral branches short and glabrous. All, however, are most conveniently included in the great genus *Aristida*.

2. Stipa, Linn., is almost as numerous and as widely spread as *Aristida*. It is also strongly characterized, as to the great majority of species, by the narrow, rather hard fruiting glume, carrying off a rather long or obconical internode of the rhachilla (or so-called callus), by the long undivided awn more or less articulate on the glume and usually twisted at the base, and by the presence of three lodicules; but the exceptions to one or more of these characters are more numerous than in *Aristida*; the internode of the rhachilla varies much in length and in shape, the articulation and twist of the awn gradually disappear in some species, and the third lodicule, though often as large as the others, is sometimes much smaller or even quite obsolete. The genus is also not so clearly divisible into sections as *Aristida*, although several genera have been proposed for more or less aberrant species. *Macrochloa*, Kunth, includes *S. tenacissima*, Linn., and *S. arenaria*, Brot., both from the Mediterranean region, remarkable for their large membranous glumes, the flowering one shortly bifid at the apex. In *Aristella*, Bertol., founded on *S. aristella*, Linn., a European and Mediterranean species, in *Streptachne*, Br., a single Australian species, and in *Orthoraphium*, Nees, two or perhaps three East-Indian species, the flowering glume is 2-toothed or shortly bifid at the apex, the awn scarcely or not at all articulate, and the internode of the rhachilla very short, though still perhaps slightly thickened under the flowering glume. The *S. aristella*, however, is very closely connected with typical *Stipæ* through *S. sibirica*, Lam., *S. Redowskii*, Trin., and *S. altaica*, Ledeb. *Jarava*, Ruiz and Pav., was founded on *S. jarava*, Kunth (*S. eriostachys*, Cav., *S. papposa*, Nees), a widely-spread West-American species, to which the small spikelets in a long narrow dense panicle, with the flowering glumes crowned under the awn

by a pappus-like ring of long hairs, give a very peculiar aspect; but precisely similar flowering glumes are observable in several South-American species with very various habits. In the European *S. pennata*, Linn., and a few other American as well as Old-World species, the awn itself is (almost entirely, or for a short distance above the base) plumose with long spreading hairs. *Lasiagrostis*, Link (*Achnatherum*, Beauv.), was proposed as a genus for the European *S. Calamagrostis*, Wahlenb., and extended by Nees and Trinius to several African and Asiatic species, only differing from other small-flowered *Stipæ* in the flowering glume itself being plumose with spreading hairs, either below the middle or in its whole length; and in *S. mongholica*, Trin., forming the genus *Ptilagrostis* of Grisebach, these hairs extend to halfway up the awn. *S. verticillata*, Nees, from Australia, and *Apera arundinacea*, Hook. f., from New Zealand, two plants closely resembling each other, though specifically distinct, connect *Stipa* with *Muehlenbergia*. They have the inflorescence and small spikelets of the latter genus; and in *S. verticillata* the awn is generally persistent, though the articulation is distinctly traceable on the flowering glume; in *S. arundinacea* the awn is very deciduous; in this species there is usually but one stamen, whilst in *S. verticillata* there are the normal three. *S. rariflora* (*Muehlenbergia rariflora*, Hook. f.), from Antarctic America, is another species closely allied to the above two; and all three appear to be better placed under *Stipa* than under *Muehlenbergia*.

3. Oryzopsis, Mich. (*Urachne*, Trin.), is a genus of about four-and-twenty species, from the temperate and subtropical regions of the northern hemisphere or from extratropical South America, very rare within the tropics, most of them often regarded as awned species of *Milium*, but really more nearly connected with *Stipa*, from which they chiefly differ in the broader fruiting glume, often oblique at the top, the awn usually short, slender, and twisted, and very deciduous. The genus divides readily into three sections, regarded by some as distinct genera, but all united into one by Trinius and others. 1. *Piptatherum*, Beauv., comprises the Old-World species, often included in *Milium* as a section, with awned glumes, and really connecting in some measure the two genera. The obliquity of the fruiting glume is much less marked than in the typical species of *Oryzopsis*; and the rhachilla of the spikelet is glabrous. 2. *Euoryzopsis* or *Oryzopsis* proper, including the proposed genera *Caryochloa*,

Spreng., *Piptochætium*, Presl, and *Nassella*, E. Desv., is entirely American, with the typical character of the genus, and the rhachilla bearing a ring of hairs under the flowering glume. 3. *Eriocoma*, Nutt. (*Fendleria*, Steud.), differs from *Euoryzopsis* only in the long silky hairs clothing the fruiting glume.

4. Milium, Linn., was formerly extended to several unawned Paniceæ with only two empty glumes, but is now reduced to five or six European or temperate Asiatic species, one of which is also spread over North America, all removed from Panicaceæ as having the empty glumes persistent below the articulation. They differ from *Oryzopsis* chiefly in their obtuse absolutely unawned flowering glume. 5. Aciachne, Benth., is a single dwarf tufted diœcious grass from the higher mountains of Peru and Colombia. The female individual, with only one spikelet terminal on the peduncle, is fully described and figured in the last part of Hooker's 'Icones.' The male plant, if correctly matched, of which I am by no means certain, has a loose almost simple panicle with precisely the glumes of the female, but enclosing stamens only. In the few specimens seen the leaves are much longer than in the numerous females from various localities, which makes me rather doubt the specific identity of the two.

6. Muehlenbergia, Schreb., has nearly sixty known species, chiefly American, extending from the Andes of South America over the northern continent generally, with a very few from central or eastern Asia. They connect, in many respects, *Stipa* with *Agrostis*. In general they come very near in technical character to the smaller-flowered *Stipæ*, differing in the still smaller spikelets with thinner though still closely appressed and narrow fruiting glumes, and usually with a more or less hairy rhachilla. From *Agrostis* and its immediate allies they may be readily distinguished by this narrow appressed fruiting glume with a terminal never dorsal awn; a very few unawned species are scarcely separable from *Epicampes*, except by the shape of the glume. There is a considerable variety in the inflorescence and in the proportions of the glumes, but nothing definite enough to establish good sections, although several separate genera have been proposed. In the original *M. diffusa*, Schreb., and its immediate allies, the panicle is usually long, narrow, and dense, and the lower empty glumes are very minute; whilst in Trinius's proposed section *Acroxis* both the lower glumes or one only of them are nearly as large as the flowering one; but throughout the

genus the relative size of these glumes appears to vary almost from species to species. *Vaseya*, Thurb., is a Californian species, *M. comata*, Thurb., closely resembling the more common *M. sylvatica*, Torr., except in the long hairs surrounding the thin flowering glume. *Podosæmum*, Desv. (*Trichochloa*, Beauv.), comprises a number of elegant species, in which the spreading panicle has a number of small long-awned spikelets on long capillary branches and pedicels. *Tosagris*, originally separated by Beauvois from *Podosæmum* on account of the long hairs on the back of the flowering glume, was subsequently reunited with it by the author himself. *Clomena*, Beauv., is *M. clomena*, Trin. (*M. nana*, Benth.), a dwarf Andine species, in which the second empty glume is the largest of the spikelet, and rather broadly three-toothed. The same character is observable in *M. gracilis*, Trin., forming Nuttall's genus *Calycodon*.

7. Brachyelytrum, Beauv., is a single North-American species, very near to some species of *Stipa*; but the rhachilla is produced beyond the flowering glume into a little bristle, sometimes bearing a minute rudimentary glume, which does not occur in any other species of the subtribe. 8. Perieilema, Presl, contains three or four tropical or subtropical American species, with much of the habit and many of the characters of *Muehlenbergia diffusa*, but with the empty glumes awned as well as the flowering one.

Our second subtribe, Phleoideæ, is chiefly characterized by the inflorescence. The panicle is condensed into a globular or oblong head or cylindrical spike; the rhachilla is, in a few species only, produced beyond the flower into a small bristle; the flowering glume either is awnless or bears one or three terminal awns, and when in fruit is thinner than in Stipeæ, more loosely enclosing the grain as in Euagrosteæ. The following seven genera, or most of them, have already been placed in juxtaposition by various Agrostologists.

9. Lycurus, H. B. K. (*Pleopogon*, Nutt.), consists of two closely allied American species, perhaps varieties of a single one, readily known by the empty glumes as well as the flowering one awned, as in *Perieilema*, the lowest one having usually two or even three awns. The long dense cylindrical spike (or spike-like panicle) with sterile spikelets intermixed with the perfect ones brings the genus in connexion with the subtribe Seslerieæ of Festuceæ; but there is never more than a single flower in the spikelet.

10. Echinopogon, Beauv. (*Hystericina*, Steud.), a single Australian and New-Zealand species, has likewise sterile spikelets intermixed with the perfect ones; but the empty glumes are awnless, and the flowering one three-lobed with the middle lobe produced into a long awn. 11. Diplopogon, Br. (*Dipogonia*, Beauv.), also a single Australian species, has a short awn to the empty glumes and three to the flowering one, of which the central one is long and twisted. 12. Amphipogon, Br. (*Ægopogon*, Beauv., not of Willd., *Pentacraspedon*, Steud.), five Australian species, has the flowering glume deeply three-lobed and frequently awned, and the palea also with two rigid almost awn-like lobes. *Gamelythrum*, Nees, is the *A. turbinatus*, Br., separated from *Amphipogon* only on account of a more distinct elongation of the rhachilla between the outer glumes and the flowering one.

13. Heleochloa, Host (*Pechea*, Pourr.), contains seven or eight Mediterranean species, of which one or two are widely dispersed over Europe and Central Asia. Kunth referred them to a section of *Crypsis*; and Host himself subsequently assented to the union, probably misled by an apparent resemblance of some varieties of *H. schœnoides* to the true *Crypsis aculeata*; but the resemblance is apparent only, the two genera are as essentially different in inflorescence as in the structure of the spikelets. The axis of inflorescence, or receptacle, in *Crypsis* is a flat disk; in *Heleochloa* it is a more or less elongated linear rhachis, cylindrical even in those varieties where the spike-like panicle is contracted into a sessile head. In *Crypsis* the empty glumes are above the articulation and fall off with the spikelet, and the glumes are quite those of Oryzeæ without any two-nerved palea; in *Heleochloa* the empty glumes persist below the articulation, and the glumes and palea are entirely those of Phleoideæ; and although in the commonest species the spikelike panicle or head is short and sessile, yet there are others where it is long, narrow-cylindrical, and pedunculate. *Rhizocephalus*, Boiss., founded on *Crypsis pygmæa*, Jaub. and Spach, makes, with *C. ambigua* and *C. crucianelloides* of Balansa, a very good section of *Heleochloa*, distinguished by the dwarf tufted habit and the spikelets almost echinate with the rigid points of the glumes. Beauvois gave the same name *Heleochloa* to a supposed genus, apparently made up of a *Sporobolus* and a *Phleum*.

14. Maillea, Parlat., is the *Phalaris crypsoides*, Durv., a dwarf

tufted Greek plant, with the spikelets flat as in *Phalaris*, but otherwise showing nearly the structure of *Phleum*.

15. PHLEUM, Linn., about ten species from the temperate and northern regions of the northern hemisphere or from Antarctic America, is a well-known and already well-defined genus. It has been proposed to separate generically *Chilochloa*, Beauv. (*Achnodon*, Link), for the few species in which the rhachilla is produced beyond the flower into a minute bristle; the character, however, is in this instance very trifling and uncertain. *Achnodonton*, Beauv., is *P. tenue*, Schrad., for which I can find no separate generic character. The anomalous *Phalaris trigyna*, Host, appears to have been an individual specimen of *Phleum Michelii*, All., having abnormally three style-branches instead of two.

In a third small group or subtribe, SPOROBOLEÆ, I should propose to place *Sporobolus* itself, with the three monotypic genera *Mibora*, *Coleanthus*, and *Phippsia*. The subtribe is not very clearly defined; but my previous endeavours to associate *Sporobolus* with *Milium* and *Isachne*, to which I shall recur further on, proved still less satisfactory. The plants now grouped together have small paniculate or almost racemose spikelets, awnless glumes, no continuation of the rhachilla beyond the flower, and the ripe grain only half enclosed in and readily falling away from the glume—characters sometimes well marked, but in some species rather vague.

16. MIBORA, Adans. (*Chamagrostis*, Borkh., *Sturmia*, Pers., *Knappia*, Sm.), is a dwarf slender tufted European annual, with a simple spike and the lower empty glume at least as long as the flowering one. 17. COLEANTHUS, Seid., is a minute annual, first found in Bohemia, then in Norway, and more recently gathered in the island of Sauvies at the mouth of the Oregon in North-west America. It is very near *Phippsia* and *Sporobolus*; but the lower empty glumes are entirely deficient. It was first discovered by Seidel, and distributed by him under the name of *Coleanthus subtilis*; but Trattinick in publishing it (as reported by Rœmer and Schultes) retained only Seidel's specific name, changing the genus to *Schmidtia*. Rœmer and Schultes in their 'Systema' restored Seidel's name, which Sternberg, rather later, changed again both generically and specifically to *Schmidtia utriculosa*. Under these circumstances Seidel is now considered to have published his *Coleanthus subtilis* sufficiently for general adoption, more especially as another very different genus of Grasses has

received the name of *Schmidtia*. 18. Phippsia, Br., is a dwarf paniculate slender Arctic grass, chiefly distinguishable from *Sporobolus* by the minute lower empty glumes.

19. Sporobolus, Br. (*Vilfa*, Beauv., *Agrosticula*, Raddi, *Triachyrium*, Hochst., *Cryptostachys*, Steud.), is now a genus of about eighty species, spread over the warmer and temperate regions of both the New and the Old World, mostly, however, American, with a very few European or Asiatic. Included by the older authors in *Agrostis*, it has since been universally acknowledged as distinct, though different characters have been assigned to it. Beauvois, who attached primary importance to the presence or absence of the awn, referred to it all the unawned species of the old genus *Agrostis*. Brown, who first pointed out the differences in the fruit, took as the principal character the loose membranous pericarp readily detachable from the seed; but this, though very conspicuous in *S. indicus*, Br., and in some other species, is not apparent in the dried state in several others; and in *S. virgicus*, Kunth, and others, it is only when soaked that the pericarp can be detached. On this account it has been attempted to establish two genera, *Vilfa* and *Sporobolus*; but the character is far too indefinite, as well as uncertain, to be available even for sectional separation. As a whole, *Sporobolus* is chiefly distinguished from *Agrostis* by the total absence of any dorsal awn, and by the grain so loosely enclosed in the glume that it usually protrudes from it when ripe, and often falls away. The palea also generally splits readily into two, and in some species is even at the time of flowering divided to the base, a character which Grisebach, who only observed it in an Argentine species, was induced to take as that of a new genus *Diachyrium*; but it exists in many other species; and this divided palea has been more than once described, and even figured (as in T. Nees's 'Genera Floræ Germanicæ'), as a two-valved pericarp, a character unknown in Gramineæ. Brown's name *Sporobolus* was rejected by Beauvois, Trinius, and others on the supposition that the genus is identical with the older established *Vilfa*, Adans. That, however, is a mistake. Adanson's character of *Vilfa* is so vague that it cannot be identified by that alone; but in his index he fixes it by quoting two European species, which are certainly both of them true species of *Agrostis*.

Two North-American species of *Sporobolus*, *S. compressus*, Trin., and *S. serotinus*, A. Gr., are exceptional, not only in the

genus, but in the whole tribe of Agrosteæ, by the spikelets containing occasionally two flowers (without awns or continuation of the rhachilla) as in Isachneæ and in some species of *Aira* and *Colpodium*; but the small spikelets and carpological characters are quite those of *Sporobolus*.

There remain for the Euagrosteæ, or fourth and last subtribe of Agrosteæ, about sixteen genera, of which the general character is a dorsal usually twisted awn on the flowering glume, the grain neither so closely enveloped in the fruiting glume as in Stipeæ, nor so readily exposed as in Sporoboleæ, and the spikelets usually small, loosely paniculate, very rarely condensed into a head as in Phleoideæ; but there are exceptions to every one of these characters, and the limits of the larger genera are so vague as to render this portion of the genera of Gramineæ the least satisfactory of the whole series. Of the sixteen following genera, the first seven show none of that continuation of the rhachilla beyond the flower which in the others takes the form of a glabrous or hairy bristle rarely reduced to a mere tubercle; the last four of the series, as well as *Triplachne*, have, besides the dorsal awn, two or four teeth to the glume, sometimes produced into straight awns. A few species or monotypic genera have no awn to the flowering glume, but otherwise in the structure of the spikelet are nearer to *Agrostis* than to *Sporobolus*.

20. Epicampes, Presl, about sixteen species from Mexico and the South-American Andes, probably reducible to about two thirds of that number, is a genus most embarassing to the systematist; for it seems to connect *Muehlenbergia* and *Sporobolus* with *Agrostis*. The chief general feature is the long narrow dense panicle with very numerous rather small spikelets, the awn of the flowering glume, when it exists, much smaller than in *Muehlenbergia* and often not quite terminal; the unawned species distinguished from *Sporobolus* by the fruiting glume and grain nearly those of *Agrostis*, and from the latter genus by the inflorescence and by the awn when present being very small and almost terminal. Several of the published species, however, are unknown to me; and a further study may require considerable modification of the generic character and limits. *Crypsinna*, Fourn., which appears inseparable from *Epicampes*, is founded on the *E. macroura* (*Cinna macroura* and *C. stricta*, Kunth), a Mexican species remarkable for the very long, narrow, almost spikelike panicle. *Cinna macroura*, Thurb., from California, is a

distinct species (*E. rigens*, Benth.) with a still longer and narrower rigid spikelike panicle often interrupted; and the spikelets are small, with membranous glumes, as in the typical *E. stricta*, Presl, but awnless or nearly so.

21. Bauchea, Fourn., a single Mexican species unknown to me, might perhaps be reduced to *Epicampes*, from which it is said to differ chiefly in a great inequality of the two empty glumes.

22. Agrostis, Linn., even after being shorn of a number of heterogeneous plants ascribed to it at various times from general aspect, and after the suppression of numerous names given to local representatives of cosmopolitan species, is still a genus of nearly a hundred species, generally spread over nearly the whole world, but especially common in the temperate regions of the northern hemisphere. Among the Euagrosteæ without any continuation of the rhachilla they are generally known by the absence of those peculiarities which have induced the separation of several of the preceding as well as of the following genera, by the thin short broad flowering glume with the dorsal awn below the middle, and by the palea not more than half as long as the glume, and often quite minute or even deficient; the panicle is also usually loose, very elegant, with numerous small spikelets or almost capillary branches and pedicels. There are, however, here, as elsewhere, exceptional species which defy all neat classification; even the dorsal awn is sometimes reduced to a minute tubercle, or only to be guessed at by the abrupt termination of the central nerve of the glume. The American species in which the palea is minute or deficient formed Michaux's genus *Trichodium*, which has been extended to the European *A. canina*, Linn., and others with that character, to which Beauvois restricted the Linnean name *Agrostis*, whilst he gave the name of *Agraulus* to the species in which the palea is more developed.

23. Chæturus, Link, is a single Spanish annual, much like some species of *Agrostis*, but anomalous in the group in having the lowest (empty) glume larger than the others, and produced into a long awn, whilst the flowering one, though shaped as in *Agrostis*, has no awn. The inflorescence is also peculiar, each branch of the panicle terminating in the three shortly pedicellate spikelets.

24. Arctagrostis, Griseb., is a single arctic species, referred by Brown doubtfully to Trinius's genus *Colpodium*, but which appears to be more nearly allied to *Deyeuxia*. It is, however,

one of those plants which, by irregularity in some characters usually very important, is very difficult to place satisfactorily. The habit and size of the spikelets are more those of *Poa* than of *Agrostis*; but, in the great majority of specimens, the one-flowered spikelets without any continuation of the rhachilla are quite those of Agrosteæ, and the palea is fully the length of the glume as in *Deyeuxia*. Very rarely specimens have presented themselves with a minute continuation of the rhachilla; and Brown, in a single Melville-Island specimen, found it to bear an empty glume or second flower, thus showing a connexion, and possibly, in the specimen mentioned by Brown, a hybrid between *Arctagrostis* and *Poa alpina*.

25. CALAMAGROSTIS, Adans., as now limited, comprises four or five species from Europe and northern and central Asia, of which one has also been found in South Africa, possibly, but not certainly, introduced there. Some authors extend the genus so as to include the greater part of *Deyeuxia*, and indeed all the Euagrosteæ with a hairy rhachilla; but it seems more natural if confined to the typical species, which, like *Agrostis*, have no continuation of the rhachilla or rarely a very slight one, and bear on the flowering glume a fine dorsal awn, rarely reduced to a minute point. They differ from *Agrostis* in the ring of long hairs surrounding the flowering glume, and generally in their tall almost reed-like habit, whence their generic name, and on which account they have often been placed in juxtaposition with *Arundo*. They appear, however, to be in every respect true Agrosteæ; and there are two species, *C. tenella*, Kunth, and *C. olympica*, Boiss., which are almost intermediate between *Calamagrostis* and *Agrostis*, especially as a few species of true *Agrostis* are not entirely without hairs on the rhachilla.

26. CINNA, Linn. (*Abola*, Adans., *Blattia*, Fries), is limited by modern authors to two species from the northern regions of Europe and America, with the tall reedlike habit of the larger species of *Calamagrostis*, but with a glabrous rhachilla, and remarkable in the tribe by the palea having only one nerve, although there is every reason to believe that it is a true palea, the apparently single nerve being due to the consolidation of two. Both species appear also constantly to have but one stamen in the flower. Some botanists unite the two; but from dried specimens they appear quite distinct. Amongst other minor points, the original *C. arundinacea*, Linn., has generally a minute continua-

tion of the rhachilla, which I have never found in *C. pendula*, Trin. (*C. expansa*, Link, *C. latifolia*, Griseb.). Several American or other grasses published as species of *Cinna* are now referred to *Epicampes* or *Deyeuxia*.

27. Gastridium, Beauv., has two species from the Mediterranean region, one of them also found in tropical Africa and in extratropical South America, but possibly introduced only in the latter locality. They have the small spikelets of *Agrostis*, but a narrower closer panicle, and are remarkable for the outer glumes rather hardened, shining, and ventricose at the base, whence the generic name. The older authors included them in *Milium* on account of that hardness in the glumes.

28. Chætotropis, Kunth, is a single Chilian species which some would unite with *Agrostis*, and might well have been joined to *Epicampes*, but that the rhachilla is produced beyond the flower into a rather long hairlike seta.

29. Triplachne, Link, is the *Gastridium nitens*, Coss. et Dur., a single Mediterranean species, with the habit, but not the ventricose glumes, of that genus, and differing both from that and from *Agrostis* in the flowering glume bearing a short awn-like point on each side of the awn.

30. Apera, Adans. (*Anemagrostis*, Trin.), has two very closely allied European species extending into Western Asia, with the technical character very nearly of *Deyeuxia*, but with the elegant panicle and numerous small glabrous spikelets of many species of *Agrostis*, in which they are still included by some under the name of *Agrostis spica-venti*. The New-Zealand plant described by Hook. f. as an *Apera* is now transferred to *Muehlenbergia*.

31. Cinnagrostis, Griseb., from Tucuman in South America, is unknown to me, but is said to differ from *Deyeuxia* in having the spikelets unisexual by abortion. It should most probably be incorporated in that genus.

32. Deyeuxia, Clarion (*Lachnagrostis*, Trin.), has now nearly a hundred and twenty species, dispersed over the temperate or mountain regions of the globe, particularly numerous in the Andes of South America, and extending northwards to the Arctic circle and southwards to the extreme end of South America. It is in some respects polymorphous, running on the one hand almost into *Agrostis*, to which some species have been referred, and on the other into *Calamagrostis*, with which the northern species have been often united. It differs from both in the pro-

longation of the rhachilla into a bristle or stipes usually, but not always, hairy, and from *Agrostis* in the larger spikelets, with the palea nearly as long as the glume, and the usually hairy rhachilla. There are, however, a few species where one or another of these characters fail; and one or two scarcely differ from *Apera* except in the habit and in the awn being more decidedly dorsal. *Bromidium*, Nees (to which belong *Didymochæta*, Steud., and *Chamæcalamus*, Meyer), contains a few Andine Chilian or Australian species, which, with the minute glabrous and perhaps not constant continuation of the rhachilla, might almost as well be transferred to *Agrostis*, but that they have rather the habit of *Deyeuxia*. *Relchela*, Steud. (*Agrostis sesquivalvis*, E. Desv.), *Cinnastrum*, Fourn. (at least as to *Deyeuxia poæformis*, Kunth), *Deyeuxia mutica*, Wedd., and *D. breviglumis*, Benth., with a few other South-American species, form a little group with a glabrous rhachilla and the awn reduced to a small point. In *Achæta*, Fourn., two Mexican species, the awn appears to be deficient; but all the other characters are those of the typical *Deyeuxiæ* with a hairy rhachilla, to which I would also refer the *Agrostis æquivalvis*, Trin., forming Grisebach's section *Podagrostis*.

33. Ammophila, Host (*Psamma*, Beauv,), comprises four species, two of them widely spread over the northern hemisphere chiefly near the sea, and two confined to North America. They are distinguished from *Deyeuxia* by their tall habit, their usually dense inflorescence, and especially by their larger paleaceous glumes.

34. Dichelachne, Endl., two Australian or New-Zealand species, with a narrow dense panicle, differs from *Agrostis* and its allies in the flowering glume scarcely smaller than the outer empty ones and often toothed, and in the long dorsal awns giving the inflorescence a fine bristly aspect.

35. Trisetaria, Forsk. (*Anomalotis*, Steud.), is a maritime Syrian and Egyptian plant, very near *Dichelachne*, but still more bristly, the lateral teeth of the flowering glumes being produced into fine straight awns, whilst the dorsal one is longer and flexuose. Labillardière and Delile both mention two fertile flowers in the spikelet. I have only been able to find one in several specimens examined, all from Alexandria; possibly they may have considered the rather long continuation of the rhachilla as a second flower.

36. Pentapogon, Br., is a single Australian species, with four

straight awns to the flowering glume, besides the long rigid twisted dorsal one, which, as well as the single flower, removes the genus from the Pappophoreæ.

37. LAGURUS, Linn., is a well-known widely spread Mediterranean grass, which, like *Trisetaria*, has two slender awns to the flowering glume besides the more rigid dorsal one, but is well marked by the capitate inflorescence, to which the long hairs of the linear plumose empty glumes give a peculiar soft silky aspect.

Tribe IX. ISACHNEÆ.

This small tribe is a modification of the subtribe I proposed in the 'Flora Australiensis' under the name of Milieæ, and which I distinguished from Agrosteæ by the absence of the dorsal awn, and from Festuceæ by the single or two equal flowers in each spikelet; and I included in the group both *Milium* and *Sporobolus*. Since I have worked up the Agrosteæ of the northern hemisphere, however, I find that the presence or absence of the dorsal awn is much more uncertain than I had thought, that *Milium* cannot be removed far from *Oryzopsis*, and that *Sporobolus* must be referred back to Agrosteæ. But there remain a group of genera, nearly related both to Agrosteæ and to Aveneæ, but never showing the dorsal awn so general in those tribes, and enclosing in each spikelet two equal flowering glumes and flowers, apparently inserted at the same point without any development of the rhachilla between them (except in *Cœlachne*) and never any continuation beyond the flowers. The two flowers are both hermaphrodite and fertile; or occasionally only one of them, usually the upper one, is female or sterile. The tribe thus limited would consist of the following seven genera:—

1. PRIONACHNE, Nees, subsequently republished by the same author under the name of *Chondrolæna*, is a South-African annual with an almost simple terminal spike, distinguished by the outer empty glumes as long as the flowering ones, with a rigid pectinately-toothed cartilaginous keel. *Ktenosachne*, Steud., is most probably the same plant.

2. ISACHNE, Br., comprises about twenty tropical or subtropical species, chiefly from the Old World, but including a few American ones. The small spikelets with the loosely paniculate inflorescence and more or less hardened fruiting glumes give them the appearance nearly of some species of *Panicum*, to which

genus some species of *Isachne* have been referred, but from which they constantly differ in the empty glumes persistent below the articulation, and in the two flowers both hermaphrodite or female, though one may be occasionally sterile. *Graya*, Nees (judging from the reference to Wight, but not from Steudel's characters) is *Isachne pulchella*, Roth (*Panicum bellum*, Steud., *P. malaccense*, Trin.). *Panicum Gardneri*, Thw., which, as the author observes, is closely allied to *Isachne Walkeri*, Wight, appears to me to be strictly congener with that species, although one of the flowers of the spikelet is frequently, but not always, sterile. It seems to be the same as *Isachne nilaghirica*, Hochst.

3. Zenkeria, Trin., very well described and figured in the 'Linnæa,' vol. xi., now contains two species from the East-Indian peninsula and Ceylon, both very near *Isachne*, but with membranous fruiting glumes. *Amphidonax Heynei* and *A. tenella*, Nees, do not differ from the typical *Z. elegans*, Trin. The second species is *Z. obtusiflora* (*Amphidonax obtusiflora*, Thw.). The original genus *Amphidonax* of Nees was founded on a species of *Arundo*.

4. Micraira, F. Muell., is a single North-east Australian species recently figured in Hooker's Icones. 5. Cœlachne, Br., comprises three East-Indian, Chinese, or East-Australian species—*C. pulchella*, Br., *C. perpusilla*, Thw., and *C. simpliciuscula*, Munro (*Isachne simpliciuscula*, Wight et Arn.), which, as above observed, are anomalous in the tribe by a slight extension of the rhachilla between the flowering glumes. 6. Airopsis, Desv., restricted to the single West-Mediterranean *A. globosa*, is a pretty little annual, formerly placed in *Milium* on account of the hardening of the glumes, or in *Aira*, which it resembles in many respects. It shows, however, all the characters of Isachneæ, and is indeed technically nearly allied to *Isachne* itself; but the two semiglobose fruiting glumes, closely appressed to each other by their flat faces, give the spikelets the peculiar globular shape expressed by the specific name.

7. Eriachne, Br., comprises twenty-two species, two of them endemic in tropical Asia, the remainder Australian, of which one is also in East India. They differ from *Isachne* generally in their rather larger spikelets, and especially in the long hairs on the back or margins of the flowering glumes, and sometimes in the fine straight awns terminating the flowering glumes, or even the teeth of the paleæ. *Megalachne*, Thw. (not of Steud.), is *Eriachne triseta*,

Nees, in which these awns are particularly conspicuous. The African species referred by Nees to a section *Achneria* of *Eriachne*, form a distinct genus of Aveneæ, for which Munro has retained this name *Achneria*, the original genus *Achneria* of Beauvois having been proposed for those true Australian species of *Eriachne* which have no awn or only a very small one.

Tribe X. Aveneæ.

This tribe has been more generally recognized and subjected to less variations than most of the others. Its general characters—the paniculate inflorescence, the spikelets with two or more perfect flowers, the rhachilla produced beyond the upper flower, and a twisted awn to the flowering glume either dorsal or terminal between the two lobes or teeth of the glume—suffer fewer exceptions than usual. *Aira* alone has no continuation of the rhachilla; and *Anisopogon* alone has only one perfect flower in the spikelets. Of the following sixteen genera, the first eleven have the awn dorsal and the lowest flower hermaphrodite; the next three have the male or sterile flower below the perfect one; and the last two have the lowest flower hermaphrodite and the awn terminal.

1. Aira, Linn., was once made to include *Corynephorus*, *Deschampsia*, and indeed almost all the Aveneæ with loosely paniculate inflorescence and small two-flowered spikelets, but has since been so thoroughly dismembered by various European botanists as not to leave a single species to represent the old Linnean name. Taking, however, the widely spread *A. caryophyllea*, Linn., as a genuine type, and adding to it five or six European species, we have a natural genus of elegant, slender, mostly annual grasses with fine filiform leaves, the small spikelets always two-flowered without any continuation of the rhachilla beyond the upper flower, the dorsal awn of the flowering glumes rarely wanting, and the ripe grain often adhering to the palea; the latter character, however, is always uncertain. These six or seven species have all been made the types of supposed distinct genera. *A. caryophyllea*, Linn., and *A. præcox*, Linn., considered as typical *Airæ* by Parlatore and others, form the genus *Fussia*, Schur, in which the two flowers are closely contiguous and the flowering glumes usually awned. *Fiorinia*, Parlat., is the *A. Tenorii*, Guss., distinguished by the absence of the awn; but Gussone has shown that it varies with or without the awn. *Antinoria*, Parlat., is the *A. agrostidea*, Lois., with the rhachilla more or less lengthened between the

flowers, and the glume usually unawned; but *A. pulchella*, Willk., with the glume awned, cannot be otherwise distinguished from it. *Periballia*, Trin., is the *A. involucrata*, Cav., in which the two flowers are as in *A. agrostidea* rather distant from each other, the lowest flowering glume unawned, the upper one awned, but both flowers hermaphrodite, as in the rest of the genus. The inflorescence of this species is rather peculiar; the lowest whorl of branches of the panicle are usually without any or with only very few spikelets, and were regarded by Cavanilles as an involucre: but that is not always the case; I have seen some specimens with spikelets on all the branches. *A. sabulonum*, Labill., from New Caledonia, is a very doubtful plant. Labillardière's figure is a good representation of the Australiasan form of *Sporobolus virginicus*, except that the spikelets are drawn as two-flowered. The specimens sent for Labillardière's plant by Pancher and by Vieillard have only one flower in the spikelet.

2. Corynephorus, Beauv. (*Weingartneria*, Bernh.), comprises two European grasses, extending into North Africa and more sparingly to the Levant, with the continuation of the rhachilla of *Deschampsia*, but readily distinguished by the peculiar articulate club-shaped awn of the flowering glumes.

3. Deschampsia (*Campelia*, Link) is a genus of about twenty species, from the temperate or colder regions of both the New and the Old World, sparingly represented in mountain regions within the tropics. It bears the same relation to *Aira* that *Deyeuxia* does to *Agrostis*; the plants are usually perennial and stouter than in *Aira*, the spikelets larger, and the rhachilla is produced beyond the upper flower into a bristle often bearing a tuft of hairs, and sometimes an empty glume on even a male flower; the flowering glumes are also frequently more or less denticulate. No less than six of the species have been proposed as distinct genera:—*Vahlodea*, Fries, is *D. atropurpurea* (*Aira atropurpurea*, Wahlenb.), a northern species, with the flowering glume not at all or only very minutely denticulate, otherwise quite a *Deschampsia*. *Avenella*, Parlat. (*Lerchenfeldia*, Schur), is the common *D. flexuosa* (*Aira flexuosa*, Linn.), with the flowering glume surrounded by hairs. The grain is said by Parlatore to adhere to the palea, which may be sometimes, but is certainly not always, the case. *Monandraira*, Em. Desv., includes two Chilian species, *Trisetum Berteroanum* and *T. airæforme* of Steudel, separated from *Deschampsia* as having but one stamen to the

flower; but in *D. Berteroanum* I have sometimes found two stamens, and in the evidently nearly allied *D. antarctica*, Hook. f., the stamens, though usually three, are sometimes two only. *Airidium*, Steud., is a species from the Straits of Magellan which I am unable to distinguish from the *D. antarctica*. *Rytidospermum*, Steud., is founded on specimens of a *Deschampsia* closely allied to, if not identical with, the common *D. cæspitosa*, in which a grub has taken possession of every spikelet remaining in the panicle, and has been mistaken by Steudel for the caryopsis, and actually described as such. *Peyritschia*, Fourn., is *D. kœlerioides* (*Aira kœlerioides*, Peyr.), which I have not seen, but which, from Peyritsch's elaborate description, must be very near to *D. antarctica*, Hook. f., *D. nitida*, Presl, and *D. holciformis*, Presl.

4. Achneria, Munro, contains eight South-African species, with one from south-eastern tropical Africa, referred by Nees to *Eriachne*, and by Kunth to *Airopsis*, but evidently more nearly related to *Deschampsia*.

5. Monachyron, Parlat., is a single species from the Cape-Verd Islands, which we have not at Kew, and of which I have therefore been unable to verify the character given by Parlatore. The specimen he described most probably remained in Webb's herbarium, now deposited at Florence.

6. Holcus, Linn., formerly included two very different groups of grasses; and Brown specially retained Linnæus's name for that one which now forms the genus *Sorghum* in Andropogoneæ, whilst all modern botanists restrict the genus *Holcus* to the other group, consisting of about eight European or African species, chiefly western, of which one or two are common weeds in various parts of the world. All are nearly allied to *Deschampsia*, but have the upper flower of each spikelet male with an awned glume, and the lower one unawned and hermaphrodite. Two Spanish species have been added by Boissier, *H. grandiflorus* and *H. cæspitosus*; but as they have both the flowers hermaphrodite and awned (whence the sectional name *Homalachne*), they should rather be transferred to *Deschampsia*, although they may have the peculiar soft habit of the common species of *Holcus*.

7. Trisetum, Pers., is now known to comprise nearly fifty species, ranging over the temperate or mountain regions of both the New and the Old World. All are very near to the section *Avenastrum* of *Avena*, but differ generally in the flowering glume decidedly toothed at the apex, the two teeth often produced into

straight awns, one on each side of the dorsal twisted one, and in the grain glabrous or slightly pubescent at the apex without the longitudinal furrow of *Avena*. The inflorescence is also usually more dense than in that genus, with smaller, often shining spikelets. A few African or South-American species, however, such as *T. hirtum*, Nees, and *T. antarcticum*, Nees (which includes *Bromus antarcticus*, Hook. f., and *Bromus bicuspis*, Nees), closely connect the two genera: the flowering glume is more rigid and less keeled than in the true *Triseta*, and the ovary is pubescent at the top ;but the grain has not the furrow of *Avena*. *Trichæta*, Beauv., is the *Trisetum ovatum*, Pers., a species allied to *T. subspicatum*; but the spikelike panicle is more dense and ovoid, or almost globular. *Acrospelion* or *Acropselion*, Bess., is *Trisetum distichophyllum*, Beauv., not the *Ventenata*, Link, to which it is referred in Lindley's 'Vegetable Kingdom.' *Rostraria*, Trin., was made up of *Trisetum neglectum*, Roem. et Schult., and *Kœleria phleoides*, Pers.

8. Ventenata, Kœl., has two species, *V. avenacea*, Kœl., and *V. macra*, Balansa, from the Mediterranean region and Central Europe, differing slightly from *Trisetum* in the longer, more rigid, many-nerved glumes, and the absence of any dorsal awn on the lower flowering one.

9. Avena, Linn., as limited by recent authors, comprises about forty species, mostly from the temperate regions of the Old World, with a few from extratropical North and South America, and one or two of the annual ones cornfield weeds in other countries. It is generally characterized by the flowering glumes rounded on the back and several-nerved, with a dorsal twisted or bent awn, and by the ripe grain furrowed in front and more or less adhering to the palea, but is divisible into two sections almost marked enough in habit as well as character to be raised to the rank of genera. In 1. *Crithe*, Griseb., the species are all annual, usually tall, with a loose panicle of large pendulous spikelets, each containing no more than two fertile flowers, and often only a single one, and the lower empty glumes 7- or 9-nerved. This section includes the common *Oat*, which has lost its dorsal awn probably as a consequence of long cultivation; for the plant is unknown in a wild state, except here and there as an escape from cultivation. In 2. *Avenastrum*, Koch (*Helicotrichum*, Bess.), the plant is perennial, the panicle usually narrow, with erect or rarely spreading spikelets with more than two perfect flowers,

and the lower empty glumes with only one or three, or the second rarely with five nerves.

10. Gaudinia, Beauv., two species, has the spikelets of *Avena* (*Avenastrum*); but they are singly sessile in the notches of the articulate rhachis of a single spike, thus showing the inflorescence of the tribe Hordeæ, to which Parlatore would remove the genus; but the dorsal twisted awn places it much nearer to *Avena*, from which some authors would not generically separate it. The common *G. fragilis*, Beauv., is widely dispersed over the Mediterranean region. The second species, *G. geminiflora*, J. Gay, was proposed as a genus *Arthrostachya*, Link, from garden specimens of unknown origin; it has since been detected by Seubert in the Azores.

11. Amphibromus, Nees, is a single Australian species, with many-flowered spikelets. The grain is furrowed as in *Avena*, but glabrous and free from the palea as in *Trisetum*.

12. Arrhenatherum, Beauv., contains three European, North-African, or Oriental species, often included in *Avena*, but differing from that genus as well as from most Poaceæ in having, as in the two following genera, the lower flower male and the upper one fertile, though the rhachilla is produced beyond it as in other Aveneæ.

13. Tristachya, Nees (*Monopogon*, Presl), has eight species, of which two are tropical American, the remainder African, tropical or southern, one extending to the Levant. With the lower flower male, as in *Arrhenatherum*, they are readily distinguished by the spikelets always three together, sessile or equally pedicellate at the ends of the branches of the panicle, and by the long twisted awn of the flowering glume being terminal between two lobes or straight awns. Amongst Nees's African species, *T. simplex* must be transferred to *Trichopteryx*.

14. Trichopteryx, Nees (*Loudetia*, Hochst.), about ten African species, of which one is also in Brazil, has the spikelets of *Tristachya*; but they are scattered along the branches of the panicle, not in terminal triplets. The only Brazilian species, not uncommon also in tropical Africa, *T. flammea*, has, as already mentioned, been rather negligently published and figured as an *Arundinella*, of which it has none of the characters and not much of the habit.

15. Anisopogon, Br., is a single West-Australian species, differing from *Danthonia* in the large spikelets containing only a

single perfect flower. Nees added a second species from South Africa which I have not seen; but from his description it can scarcely be a congener. Kunth has figured three lodicules in the Australian plant; I have always found only two long lanceolate ones.

16. DANTHONIA, DC., is now a polymorphous, almost cosmopolitan, genus of nearly a hundred species, of which the greater number, however, are South-African, all characterized by the spikelets containing three or more perfect flowers, and by the awn of the flowering glumes more or less twisted or bent and usually flattened at the base, but terminal between two or four teeth or straight awns. Notwithstanding considerable diversities in habit, inflorescence, and in the size and teeth of the glumes, no good natural sections have yet been proposed. Nees's *Himantochæte* (*Streblochæte*, Hochst.), with the lateral lobes or teeth of the flowering glumes entire and acute or awned, and *Pentaschiste*, with the lateral teeth bifid and one or both teeth awned, are purely artificial, and relate to the African species, all the non-African ones being included in *Himantochæte*. DeCandolle originally proposed the genus for two European species, *D. procumbens* and *D. provincialis*; Brown showed, however, that they could not well be regarded as congeners, and removed the former to his new genus *Triodia*. The *D. provincialis* therefore becomes the type of the present large genus *Danthonia*, though it may be somewhat anomalous when compared with the majority of the African and Australian ones. DeCandolle's chief character connecting his original species was the great length of the outer empty glumes compared with the rest of the spikelet; and this is a general, though not quite a universal, feature of the enlarged genus. Since Brown's time the following genera have been proposed, chiefly upon single species, with characters which appear to be of little more than specific value:—*Pentameris*, Beauv., is *D. Thouarsii*, Nees, from South Africa, with nearly the habit and inflorescence of *D. pallescens*, Nees, but remarkable for the short thick grain truncate at the top. *Triraphis*, Nees (not of R. Br.), is *D. radicans*, Steud., from South Africa, nearly allied to *D. crispa*, Nees. *Chætobromus*, Nees, contains a few South-African species, in which one, or sometimes two, of the flowers in the spikelet are imperfect. *Monacather*, Steud., is *D. bipartita*, F. Muell., an Australian species, with the fruiting glumes hardened and oblique at the base and bearing a ring of hairs under the lobes. *Plin-*

tanthus, Steud., is founded on two Australian species, most probably of *Danthonia*, but which, from the evidently incorrect character given, it is impossible to identify without seeing the specimens. *Crinipes*, Hochst., is the Abyssinian species published by A. Richard as *D. abyssinica*, Hochst., in which the outer empty glumes are exceptionally shorter than the spikelet.

Tribe XI. Chlorideæ.

This tribe is characterized amongst Poaceæ almost exclusively by the inflorescence. The spikelets are sessile in two rows in unilateral spikes, the rhachis of which is neither articulate nor notched as in Hordeeæ; and the spikes, sometimes solitary and terminal, are more frequently several, either digitate at the end of, or scattered along, the peduncle or axis of the single panicle. The inflorescence is thus nearly that of *Paspalum*, whilst the spikelets are those of Festuceæ, with the lowest or single perfect flower hermaphrodite, and the awns, when present, terminal and straight, not dorsal or twisted as in Agrosteæ and Aveneæ. The following twenty-seven genera are mostly, but not quite all, tropical or subtropical; the first fifteen have one fertile and only rarely a second male flower in each spikelet; the next ten have two or more fertile flowers; all, except a few very small genera or exceptional species, have the rhachilla continued beyond the flowers, and often bearing one or more empty glumes. The last three genera enumerated under the tribe are anomalous diœcious grasses, connecting Chlorideæ with the subtribe Seslerieæ of Festuceæ, but showing the inflorescence of the present tribe at least in the male individuals.

1. Microchloa, Br., comprises three species, of which two are endemic in Africa and the third widely spread over the warmer regions of the New as well as the Old World. They are slender tufted grasses with filiform leaves and single slender terminal spikes and small awnless one-flowered spikelets without any continuation of the rhachilla.

2. Schœnefeldia, Kunth, is a single tropical-African species with one to four erect spikes at the top of the peduncle; the spikelets are one-flowered without any continuation of the rhachilla as in *Microchloa*, but not so small; and the flowering glumes bearing long capillary awns, give the spikes an elegant crinite aspect.

3. Cynodon, Pers. (*Dactilon*, Vill., *Capriola*, Adans., *Fibichia*,

Kœl.), a small but mixed genus, of which the typical species is a common weed in most warm or temperate parts of the civilized world. It has the slender spikes and small spikelets of *Microchloa*; but the spikes are several digitate at the end of the panicle, and the rhachilla is produced beyond it into a small point or bristle. Three Australian species have, however, been added to it with the spikelets of *Microchloa* but with the inflorescence of *Cynodon*, thus closely connecting the two genera. Persoon's generic name is far from being the oldest, but has been so long and so universally adopted, that the substitution of either of the others for it would only breed confusion without the slightest advantage.

4. Harpechloa, Kunth, has also two South-African species. The spike is single, terminal, dense, and unilateral, often falcate; and there are usually one or two male flowers above the fertile one, the glumes all unawned.

Of 5. Ctenium, Panz. (*Monocera*, Ell.), we have seven species, of which four from North or South America, three from Africa or the Mascarene islands. The spikes are solitary or rarely two or even three at the end of the peduncle; the spikelets, though elegantly pectinate as in *Harpechloa*, have a very different structure: the second empty glume is larger than the others, and bears on the back a fine horizontal point sometimes reduced to a small tubercle; the third and fourth glumes are small and empty, or only enclose a palea; the fifth or flowering glume ends in a fine awn, and above it are one or two empty ones.

6. Enteropogon, Nees, was founded on an East-Indian grass with a single long, often incurved terminal spike; otherwise very near *Chloris* except in some minor points. It now includes *Ctenium Seychellarum*, Baker, from the Mauritius, which is scarcely specifically distinct from the common East-Indian one, *E. macrostachya*, Munro (*Chloris macrostachya*, Hochst.), from Abyssinia, and an unpublished species from Mayotte in Madagascar, Boivin n. 3019, which may be thus characterized:—*E. leptophylla*, Benth., foliis angustissimis siccitate convoluto-subulatis, glumæ florentis integræ arista gluma ipsa longiore. The habit and the long unilateral spike are precisely those of the common Indian *E. melicoides*; but the leaves are very much narrower and scarcely flattened in the lower part, the spikelets rather larger, the flowering glume nearly 3 lines long, and the awn about ½ inch, and, at least in the spikelets examined, the flowering glume is quite entire, scarcely free at the point from the awn.

7. Chloris, Sw., contains about forty species, dispersed over the warmer regions both of the New and the Old World. It is for the most part a natural genus, with two or more spikes digitate at the end of the peduncle, the one-flowered spikelets in two regular close rows as in the allied genera, the flowering glume usually awned, and one, two, or more empty glumes above it; but these characters are not constant, and the structure of the spikelets is somewhat polymorphous. *C. monostachya*, Pourr., from the Mascarene islands, and *C. unispicea*, F. Muell., from Australia, are slender plants with only one or rarely two spikes, and the flowering glume as well as the upper empty one are narrow and awned. In *C. aciculare*, Br., and *C. Roxburghiana*, Edgew., from East India and Australia, and *C. radiata*, Sw., from America and Africa, the glumes are likewise narrow and awned, or the upper empty one reduced to a mere awn, but the spikes are normally several and digitate. *C. foliosa*, Willd., has also a narrow awned flowering glume; but the upper empty one is a double awn (or two awnlike glumes), and the spikes are not so closely clustered at the end of the peduncle, on which account Doell has transferred the species to *Gymnopogon*, from which it appears to me to be much further removed. In *C. pumilio*, Br., *C. pectinata*, Benth., and *C. divaricata*, Br., all from Australia, the flowering glume is distinctly two-lobed with the awn between the lobes. In a considerable number of species the upper empty glumes are broad and truncate at the top—these empty glumes being several in each spikelet in the Asiatic and Australian species, but one only in the American ones. In all the preceding species the flowering and upper glumes are awned; in five or six American or African species forming the proposed genus *Eustachys*, Desv. (*Schultesia*, Spreng.), both the flowering and the upper empty glume are obtuse and truncate, but without any awn, or only a minute point. They are, however, closely connected with the typical species of *Chloris* through *C. submutica*, Kunth. *C. villosa*, Pers., and *C. macrantha*, Jaub. et Spach, both of them described in detail and figured by Jaubert and Spach, must be transferred to *Tetrapogon*, as having their spikelets with at least two fertile flowers.

8. Trichloris, Fourn., comprises two Mexican and two extratropical South-American species. They resemble *Trisetaria* in their dense oblong crinite panicle and their three-awned flowering glumes; but the panicle is composed of simple crowded or verticillate spikes, and the spikelets, sessile in two rows on the rhachis

with one to three empty awned glumes above the flowering one, are quite those of *Chloris*. The two southern species had long been indicated and named in herbaria as constituting an independent genus (the one by J. Gay, the other by Munro); but never having been published, we must adopt Fournier's generic name for the whole. The two southern species (from Chili, Tucuman, and Buenos Ayres) are indeed so very near *T. fasciculata*, Fourn., that it will require close investigation to establish their specific differences. Another different-looking plant from Tucuman (Tweedie), much smaller, with a loose inflorescence and short-awned spikelets, shows also the essential characters of *Trichloris*.

9. Gymnopogon, Beauv. (*Anthopogon*, Nutt.), differs from all the preceding one-flowered genera in the spikelets not closely crowded, but more or less distant along the slender rhachis of the spikes, although still sessile in two rows and unilateral; the spikes themselves are scattered or verticillate along the common peduncle. There are four or five American species, northern or southern, and one from Ceylon, *G. rigidus*, Thw., forming Nees's genus *Dichætaria*, but only differing from the American ones in the spikes fewer in the panicle, and the spikelets rather larger with longer awns. Doell's *G. foliosus* and *G. pullulans* should be restored to *Chloris*, with which they agree in every respect except that the spikes are not quite so closely clustered at the end of the peduncle.

10. Monochæte, Doell, a single Brazilian species of which I have seen no specimen, is removed by Doell from *Gymnopogon*, where Martius had placed it, as having no continuation of the rhachilla beyond the flower. Nees, however, describes a bristle-like continuation, but not bearing any empty glume or awn as in *Gymnopogon*. The genus is as yet, therefore, in some measure doubtful.

11. Schedonnardus, Steud., is the North-American *Lepturus paniculatus*, Nutt., which, however, Steudel failed to recognize. Nuttall indicated its affinity to *Gymnopogon*, and evidently only placed it in *Lepturus* from not knowing the latter genus except from the imperfect characters then published. *Schedonnardus* has now been figured in the last part of Hooker's Icones; the description, accidentally omitted in printing, will appear in the next part.

12. Craspedorhachis, Benth., is a single species from east tropical Africa, allied to *Schedonnardus*, but differing in the

flexuose rhachis of the spikes bordered by a narrow membrane, in the flowering glume and palea very small and thin, resembling lodicules, and a few other minor points. It is being figured for the forthcoming part of Hooker's Icones.

13. BOUTELOUA, Lag. (*Eutriana*, Trin., *Actinochloa*, Willd.), comprises about twenty-five American species, northern or southern, but chiefly western. As in the four preceding genera, the spikes are distant along the main peduncle, and often numerous, very rarely reduced to one or two; but they are usually short, with the spikelets densely crowded in two rows on one side of the rhachis, and the rhachilla always continued beyond the single hermaphrodite flower, bearing one to three empty glumes or awns, or sometimes a male flower. The flowering and upper empty glumes usually end in three or five lobes, points, or awns; but they are often exceedingly variable in this respect even in the same specimen, and it becomes difficult to make much use of them in the arrangement of the species. The following four sections, raised by some to the rank of genera, are founded chiefly on inflorescence:—(1) *Chondrosia* or *Chondrosium*, Desv. Spikes usually few, often rather long, with numerous spikelets (more than twelve) neatly pectinate, and the terminal empty glume usually three-awned; the species rather numerous, especially in Mexico, where they run much one into another. (2) *Atheropogon*, Muehl., including *Heterostega* or *Heterosteca*, Desv. Spikes often numerous, but usually very short with few (rarely above twelve) spikelets, crowded but scarcely pectinate, or almost reduced to clusters, the terminal empty glume varying from three-awned to entire, or reduced to a single bristle. The species best known, *B. racemosa*, Lag. (*Atheropogon apludoides*, Muehl., *Dinebra curtipendula*, DC.), was associated by DeCandolle and Beauvois with the *Dinebra arabica* of Jacquin, which, however, differs essentially in its several-flowered spikelets. (3) *Triathera*, Desv. Spikes still further reduced than in *Atheropogon*, consisting usually of two to four spikelets so narrow and so close together as to appear like a single one, and perhaps sometimes really only a single one, the upper empty glume reduced to three awns, as in several species of the preceding section. There appear to be two species, *B. aristidoides* (*Dinebra aristidoides*, H. B. K., forming the genus *Aristidium*, Endl.), with two to four spikelets to each spike, and *B. triathera*, to which I should, with Munro, refer both *Triathera*, Desv., and *Triæna*, H. B. K. The spike-

lets vary in the same panicle, one, two, or three to the spike, and are themselves polymorphous. Where there are three, I have found the lowest empty glume of the lowest spikelet very narrow and awnlike, and very probably that which Kunth has described and figured as an awn at the base of the glume; in the uppermost of the three spikelets the lowest empty glume is similar to the second, the intermediate spikelet being sometimes like the upper, sometimes like the lower one. (4) *Polyodon*, H. B. K. (*Triplathera*, Endl.). Spikes few, short, and crowded at the end of the peduncle with few spikelets, the flowering glume three-awned, the two or three upper empty glumes each with three or five awns, having together the appearance of a single cluster of many awns. We have two species, *B. disticha* (*Polypodon distichum*, H. B. K.), including apparently *Atheropogon affinis*, Fourn. (not *Eutriana affinis*, Hook. f.), with the spikelets including the awns under half an inch long, and *B. multiseta* (*Eutriana multiseta*, Nees), with the spikelets and their awns above an inch and a half long, giving the plant the aspect of *Boissiera*. *Corethrum*, Vahl, is probably the same plant. He received his specimen in a collection of Syrian plants sent him by Thouin, into which it had probably got misplaced by some carelessness in sorting. No special locality is ascribed to it nor any indication of the collector; and no plant answering to Vahl's elaborate and probably accurate description is known from Syria or any part of the Levant.

14. Melanocenchris, Nees, comprises three species from East India or tropical Africa, closely resembling each other, and at first sight having the aspect of *Ægopogon* but the characters are very nearly those of *Bouteloua* (*Atheropogon*); the genus is readily distinguished from both by the linear plumose empty glumes.

The preceding genera have all only a single flower in the spikelet, the second, when present, being male only; in the following ten genera there are at least two, and often several more fertile flowers.

15. Tripogon, Roth (*Plagiolytrum*, Nees), contains about eight East-Indian and tropical-African species, with the single elongated terminal spike of *Enteropogon*, but with several-flowered spikelets, and the flowering glumes more or less three-awned as in *Trichloris*, *Triraphis*, etc., the lateral awns sometimes reduced almost to teeth.

16. Lepidopyronia, A. Rich., is a single Abyssinian species which I have not seen, and of which the specimen described is said to have been imperfect. From the figure and description it would appear to be allied to the *Tripogon abyssinicus*, Nees, but with broad, very villous flowering glumes, and the single awn not quite terminal.

17. Tetrapogon, Desf., has four Abyssinian, North-African, or West-Asiatic species, including the above-mentioned *Chloris villosa*, Pers., and *C. macrantha* of Jaubert and Spach. They have one, two, or rarely three terminal erect spikes, resembling *Elionurus* in the long silky hairs which cover them, but with the characters of Chlorideæ, differing from *Chloris* itself in their several-flowered spikelets.

18. Astrebla, F. Muell., comprises two or three Australian species formerly referred to *Danthonia*, from which the habit and untwisted awn separate them. In the 'Flora Australiensis' I placed them near Pappophoreæ on account of their many-nerved glumes; but the inflorescence places them in Chlorideæ, where they come in many respects near to *Tetrapogon*.

19. Wangenheimia, Moench (*Cynosurus Lima*, Linn.), from Spain and North Africa; 20. Ctenopsis, DeNotar. (*Festuca pectinella*, Delile), from North Africa; and 21. Tetrachne, Nees, from South Africa, are all single species hitherto referred to Festuceæ; but they have all the one-sided spikes with the spikelets sessile in two rows of Chlorideæ, to which, following out Munro's memoranda, I have transferred them. The spikes are solitary, erect, and often slightly falcate in *Wangenheimia* and *Ctenopsis*, several scattered along the common peduncle in *Tetrachne*.

22. Dinebra, Jacq., remains limited to the original African and East-Indian *D. arabica* figured by Jacquin. DeCandolle, as above mentioned, joined it with the section *Atheropogon* of *Bouteloua*, of which it has the habit; but there are always two fertile flowers to the spikelet. Kunth referred it to *Leptochloa*, from which it is further removed by its short dense awned spikes; and from both it is separated by the lower empty glumes as long as, or longer than, the rest of the spikelet.

23. Eleusine, Gærtn., taken in the sense given to it by Persoon, is a natural genus of about seven species, from the tropical and subtropical regions of the Old World, two of them common weeds also in America. The spikes are usually several, digitate

at the end of the peduncle, and in some species with the addition of others scattered or verticillate lower down. The flat spikelets have been sometimes mistaken for those of *Eragrostis*; but their arrangement in two rows is always that of Chlorideæ. The genus is often restricted to Gærtner's *E. coracana* and *E. indica*, in which the spikes are digitated and rather long, and the membranous pericarp loose on the ripe seed. This character is particularly marked in the *E. coracana*; but that is probably a plant somewhat modified by long cultivation. In the common *E. indica* the pericarp is often as loose, but sometimes remains very thin and not so easily detached. In the still more common *E. ægyptiaca*, Pers., forming the genus *Dactyloctenium*, Willd., the digitate spikes are very short and dense, and the very thin pericarp appears to wither away or to dry up in ripening, leaving the seed apparently exposed and rugose, similar to that of *E. indica*. In *E. brevifolia*, Wall. Cat., and *E. glaucophylla*, Munro (*Dactyloctenium glaucophyllum*, Courb.), the spikes are short as in *E. ægyptiaca*, and more or less of the remains of the membranous pericarp may be often seen persistent about the seed. *Acrachne*, Wight and Arn., is the *E. verticillata*, Roxb., in which the spikes are rather long as in *E. indica*; but besides the terminal digitate ones, there are others scattered or verticillate along the peduncle. *Arthrochlæna*, Boiv. in herb. J. Gay, is a remarkable Madagascar species which may be thus defined:—*E. macrostachya*, Benth., elata, foliis angustissimis rigidis crassiusculis, spicis 2–3nis terminalibus, spiculis confertis 18–20-floris, glumis acute carinatis paleaceis bifariam imbricatis. A plant of rushlike habit about 2 feet high, the spikes about 4 inches long, with very numerous spikelets varying from 4 to 6 lines long, resembling those of *Eragrostis*, but much more rigid.

24. Leptochloa, Beauv. (*Oxydenia*, Nutt.), about twelve species, tropical or subtropical, in the New as well as the Old World, and extending on the one hand into North America, and on the other into extratropical Australia, is one of those genera which interfere provokingly with our classifications. Nearest allied to *Eleusine*, it has also considerable affinity with *Cynodon*, *Diplachne*, and *Poa*, to which some of the species have been occasionally referred; and one has been figured as a *Cynosurus*. The chief character consists in the slender spikes scattered along the common peduncle, with numerous small flat spikelets, giving the

plants a different habit from that of the several preceding genera. The species may be distributed into two rather distinct sections. (1) *Pseudocynodon*, with only one or two flowers in the spikelet, differing but little from *Cynodon* except in inflorescence. To this section belong *L. uniflora*, Hochst. (*Cynodon gracilis*, Nees), from Abyssinia, *L. Neesii* (*Cynodon Neesii*, Thw.), from Ceylon, and *L. polystachya*, Benth. (*Cynodon polystachyus*, Br.), from Australia. (2) *Euleptochloa*, with two or more flowers to the spikelet, comprises the remainder of the species. Those which have a point or short awn to the flowering glume were formerly generically separated by Beauvois under the name of *Rabdochloa*. Amongst the published species, *L. arabica*, Kunth, is the genus *Dinebra*; *L. Lindleyana* and *L. mollis*, Kunth, are referable to *Triodia*. *L. dubia*, Nees (*Chloris dubia*, H. B. K.), and the North-American *L.* (*Diplachne*) *fascicularis*, A. Gray, appear both to be true species of *Diplachne*. Lorentz's South-American plant distributed by Grisebach as *L. fascicularis* appears to be a mere variety of *Panicum sanguinale*. *L. Wightiana*, Nees, is an *Eragrostis*. *L. plumosa*, Anders., is a *Triodia*.

There remain three anomalous monotypic genera from the Mexican-Texan region—25. Buchloe (*Sesleria*, afterwards *Calanthera*, Nutt.), 26. Jouvea, Fourn., and 27. Opizia, Presl, which connect in some measure Chlorideæ with the subtribe Sesleriеæ, and are all diœcious, and very remarkable for the great dissimilarity in the spikes and spikelets of the two sexes. Of the first, numerous specimens fully confirm Engelmann's excellent figures and description; the other two are unknown to me, and remain somewhat doubtful. Of *Jouvea*, Fournier only knew the female, which he says is allied to *Buchloe*, with a very different habit. *Opizia* is said by him to have the male plant exactly like *Buchloe*; the female figured by Presl must be very different, though his and Fournier's descriptions do not agree in all points.

Tribe XII. Festuceæ.

The large tribe *Festuceæ* presents considerable difficulties to the systematist. Of the seventy genera on our list (about a hundred and ten of some botanists), the greater number are perhaps better defined than those of Agrosteæ for instance, and afford a much greater variety of characters; but none of the various arrangements proposed for distributing them into groups or subtribes have proved satisfactory, and the two largest genera *Poa*

and *Festuca* are connected by a number of smaller ones, which are more variously associated together or separated by European botanists than almost any others of the Order. As a whole, Festuceæ should include all the Poaceæ with two or more perfect flowers to the spikelet, which have neither the peculiar inflorescence of Chlorideæ or of Hordeeæ, nor the dorsal or twisted awn of Aveneæ, nor the peculiar habit of Bambuseæ. But we have seen that there are a few species where the awn is wanting, but which must yet be left in Aveneæ; we shall find that in *Diplachne, Oreochloa,* and even in *Festuca* itself, there is occasionally an inflorescence very nearly that of Chlorideæ; and with regard to Bambuseæ, distinct as is the habit and foliage of the great mass of genera, yet it is exceptional in *Planotia,* and in the subtribe Centotheceæ of Festuceæ there is some approach to that of the Bambuseæ. The subdivisions proposed of the Order into subordinate groups have been so various, and often on such plausible (though sometimes contradictory) grounds, that it is not without hesitation that I have selected for adoption the following eight subtribes:—

Subtribe 1. *Pappophoreæ,* has often been raised to the rank of a substantive tribe, but with various limits; and it really is only distinguished from Triodieæ by the more nnmerous teeth, lobes, or awns of the flowering glumes. There are five well-established genera, requiring little comment.

1. Pommereulla, Linn. f., is a single East-Indian annual, with short spikes almost enclosed in the upper leaf-sheaths, and remarkable for the presence of two empty glumes between the ordinary lower pair and the flowering ones, as in *Ctenium, Eremochloa, Brylkinia,* and *Uniola.*

2. Pappophorum, Schreb., has nearly twenty species from the warmer regions of both the New and the Old World, distributed in two sections, regarded by some as distinct genera:—*Polyrhaphis,* Trin., a few American species in which the flowering glume has thirteen to twenty-three very unequal awns; and *Enneapogon,* Desv., chiefly, but not exclusively, from the Old World, in which the flowering glume has nine awns, all nearly equal, or five of them rather external and slightly different from the four inner ones.

3. Cottea, Kunth, is a single tropical American species, differing from *Pappophorum* in the looser panicle, and in the flowers usually more than two, instead of only one or two, in each spikelet.

4. Boissiera, Hochst., is a single Oriental species, which, besides the characters derived from the glumes, has a very short membranous dilated two-lobed style, different from that of every other known grass.

5. Schmidtia, Steud., contains two species closely resembling each other, one from the Cape-Verd Islands, the other from tropical and South Africa, with a narrow but loose panicle, and the flowering glumes ending in four inner lanceolate lobes, and five outer subulate lobes or awns.

Our second subtribe, *Triodieæ*, is not so definite as could be wished. There are usually more than two flowers to the spikelet; and the flowering glumes have rarely more than three nerves, and end in three teeth, lobes, or awns. These characters are generally very prominent; but in a few species of *Triodia* and *Diplachne* the teeth are scarcely more than what occur occasionally in some other subtribes, and in one or two species of *Triraphis* the nerves of the glumes are more numerous, bringing them technically near to Pappophoreæ. The panicle in all the genera is usually narrow, dense or loose, but very rarely spike-like, and in a few species loose and spreading. We include six genera.

6. Triodia, Br. (*Uralepis*, Nutt.), as at present limited, comprises about twenty extratropical species, northern or southern, with a very few extending into the tropics in America or Africa. It has the typical characters of the tribe without the peculiarities of the other genera, the lobes of the flowering glumes reduced to short teeth or points, or the central one rarely lengthened into a short awn. It must be admitted, however, that it is still both a vague and a polymorphous genus, comprising three rather distinct sections and a few anomalous isolated species:—1. *Isotria*, three Australian species (*I. Mitchelli*, Benth., *I. pungens*, Br., and *I. Cunninghamii*, Benth.) with the three lobes of the flowering glumes narrow lanceolate and equal; 2. *Uralepis* (*Sieglingia*, Bernh., *Merisachne*, Trin.), about sixteen American or Australian species with one European one, in which the lateral teeth of the glumes are broad and not pointed and sometimes very minute, the middle one a point or very short awn; 3. *Tricuspis*, Beauv. (*Windsoria*, Nutt.), three North-American species differing from *Uralepis* in the nerves of the lateral teeth produced into short points. Besides these, *Leptocarydion*, Hochst., is an Abyssinian species, *T. plumosa* (*Leptochloa plumosa*, Anders., *Diplachne alopecuroides*, Hochst.) with the dense soft panicle almost of *Tri-*

chloris, but with the spikelets of *Triodia*. *Trichoneura*, Anders., is *Leptochloa Lindleyana*, Kunth, from the Galapagos Islands, with the habit nearly of *Diplachne fascicularis*, but with the characters of *Triodia*. *Leptochloa mollis*, Kunth, from Senegal, which I have not seen, would appear from his figure to be a *Triodia*, near to the *T. plumosa*, but with the loose panicle of *T. Lindleyana*. *Rhombolytrum*, Link, is *T. filiformis*, Nees, a Chilian species, very near to the North-American *T. albescens*, and *T. trinerviglumis*, Munro, and also to *T. Kerguelensis*, Hook. f., and *T. antarctica* (*Catabrosa antarctica*, Hook. f.), from extreme southern America.

7. Diplachne, Beauv., now comprises about fourteen species, dispersed over the tropical and temperate regions both of the New and the Old World, and variously referred to *Triodia*, *Leptochloa*, or *Molinia* by different agrostologists; and the genus is really closely connected with the two first-named, but more especially with the *Triodiæ* of the typical section *Uralepis*. From these it chiefly differs in inflorescence: the branches of the panicle are long and slender; the spikelets, almost linear, scattered along the rhachis and sometimes sessile or nearly so in two rows, but not regular and unilateral enough to place the genus in Chlorideæ, to which it is sometimes referred. The characteristic teeth of the flowering glumes are also sometimes very minute. Whatever position, therefore, we give to the genus, it must be more or less an arbitrary one; but that next to *Triodia* seems the least objectionable.

8. Triplasis, Beauv. (*Diplocea*, Rafin.), has two North-American species (*Uralepis cornuta*, Ell., and *U. purpurea*, Nutt.), with a narrow, slender, slightly-branched panicle, and the flowering glumes deeply divided into three narrow lobes, the central one a slender awn. The South-American *Triplasis setacea*, Griseb., is a *Diplachne* (*D. spicata*, Doell).

9. Scleropogon, Philippi (*Lesourdia*, Fourn.), has four species, one from Chile, the others from the Mexican-Texan region, all remarkable for the unisexual spikelets, those of the two sexes so different in aspect that without positive evidence it would have been difficult to suppose them to belong to the same plant. The Mexican ones have been very well described and one of them figured by Fournier, who, from his specimens, supposed them to be strictly diœcious; but we have specimens with the two inflorescences upon different branches of the same individual.

Fournier also was not aware of the Chilian species previously published by Philippi, whose generic name necessarily takes the precedence over Fournier's.

10. Eremochloa, S. Wats., contains two New-Mexican or Californian species, well described and illustrated by S. Watson. The genus is exceptional in the subtribe in its one-flowered spikelets, and in the two empty three-awned glumes between the lower pair and the flowering one.

11. Triraphis, Br., comprises five or six species, one as yet unpublished from South Africa, the others from Australia. In all, the three lobes of the flowering glumes are awned, whilst in one species, *T. mollis*, Br., otherwise inseparable from the genus, there are additional small membranous lobes between the awns, and at least five nerves to the glume, showing a close connection with the Pappophoreæ. *T. microdon*, Benth., from Australia, is a very anomalous plant with unawned glumes, which should be removed from the genus; but it is difficult to say where it should be placed *T. capensis*, Nees, is a *Danthonia* (*D. radicans*, Steud.).

The third subtribe, *Arundineæ*, though often regarded as a substantive tribe, has no definite character beyond the tall habit with a rich panicle, as designated by the common name *Reed*, and the long hairs surrounding the flowering glumes, either arising from the rhachilla or from the glumes themselves. This character, however, is no more exclusive here than in Sacchareæ; for there are other genera, such as *Calamagrostis*, *Graphephorum*, &c., which have the hairs nearly as long, but which on other accounts cannot be included in Arundineæ. The genera certainly belonging to the subtribe are four:—12. Gynerium, Humb. and Bonpl., three tropical or subtropical American species with strictly diœcious spikelets. 13. Ampelodesmos, Beauv., two Mediterranean species with rigid five-nerved flowering glumes. 14. Arundo, Linn. (*Donax*, Beauv., *Scolochloa*, Mert. and Koch, *Amphidonax*, Nees), three or four species from the warmer regions of the New and the Old World, very abundant all round the Mediterranean, with three-nerved flowering glumes; and 15. Phragmites, Trin. (*Arundo*, Beauv., *Czernya*, Presl, *Trichodon*, Roth), two species, one of them almost cosmopolitan, only differing from *Arundo* in the lowest flower of the spikelet being male only. These last three genera are frequently, and perhaps with reason, regarded as sections only of *Arundo*. Two Mexican monotypic genera proposed by Fournier, 16. Gouinia, and 17.

Calamochloa, are unknown to me. They are placed by the author in Arundineæ; but both would appear, from the short character given, to have a rather different inflorescence.

We have formed our fourth subtribe *Sesleriеæ* of ten genera, all except the monotypic *Elytrophorus* extratropical, and connected together for the most part by inflorescence as well as by structural characters. These are, however, not without exceptions. The spikelets are usually collected together in little heads or close clusters, which are themselves closely clustered in a dense globular or spike-like panicle; and at the base of the head or panicle are usually a few barren spikelets or empty glumes, or, sometimes single glumes, which I have elsewhere, though as I now believe erroneously, designated as bracts subtending the branches of the inflorescence. In two genera the whole inflorescence is reduced to two or three spikelets sessile in a cluster of floral leaves. In structure the flowering glumes are variable in their nerves; but the styles, in almost all the genera, are long, with barbellate or very shortly plumose stigmatic branches, forming an exception to the tribe, which has induced several botanists to refer *Sesleria* itself to the Paniceæ, from which it differs so widely in other characters. We include the following genera in the subtribe:—

18. Monanthochloe, Engelm., is a single Texan species, anomalous in habit and character, well described and figured by Engelmann. It has been compared to *Buchloe* on account of its unisexual spikelets and creeping habit; but the two sexes in *Monanthochloe* are very similar to each other, and there is no indication in the inflorescence of any affinity with Chlorideæ.

19. Munroa, Torr., has now three or four species, two or three from extratropical South America having been recently added to the original Mexican-Texan one, figured in the last part of Hooker's Icones. The genus is a perfectly isolated one, showing only some slight affinity with *Monanthochloe*, especially in the very few spikelets sessile within a cluster of floral leaves; they are not, however, unisexual as in that genus.

20. Echinaria, Desf. (*Panicastrella*, Mœnch), a single well-known Mediterranean species; 21. Ammochloa, Boiss. (*Cephalochloa*, Coss. & Dur.), two Oriental or North-African species; and 22. Urochlæna, Nees, a single South-African species figured in the last part of Hooker's Icones, require no further comment on the present occasion.

23. Sesleria, Scop., about eight European or West-Asiatic species, is an old-established distinct genus which has been but little interfered with, except that *S. tenella*, Host, has been proposed as a genus by Link under the name of *Psilathera*, but upon characters which do not appear to be of more than specific value.

24. Elytrophorus, Beauv. (*Echinolysium*, Trin.), is a single exceptionally tropical species, widely spread, but limited to the Old World. The little heads of minute spikelets forming a spike longer than usual in the subtribe, and often interrupted, and the wings on one or both the keels of the palea readily distinguish the genus.

25. Fingerhuthia, Nees, a single species figured in the last part of Hooker's Icones, is exceptional in the whole primary division Poaceæ in having the very short pedicels articulate below the spikelet as in Panicaceæ, whilst the male flower or empty glume is above the fertile flower as in Poaceæ. Its geographical range is also peculiar: rather common in South Africa, it has been recently gathered by Dr. Aitchison in Afghanistan, without its ever having been observed in any intermediate station.

All the preceding genera have the long styles of the subtribe; but there remain two with the styles scarcely longer than in the other Festuceæ, whilst the barren spikelets at the base of the dense inflorescence or of its branches are very conspicuous, and show a close affinity with the Seslerieæ. These are 26. Lamarckia, Mœnch (*Chrysurus*, Pers., *Pterium*, Desv., *Tinæa*, Garzia), a single Mediterranean species, and 27. Cynosurus, Linn., three or four species with a much wider geographical range over the temperate regions of the Old World, and one of them at least now naturalized in several other countries within or without the tropics. Both genera are remarkable for the lower barren spikelets of the clusters or spikes elegantly pinnate with numerous bifarious empty glumes. The two were united by the older botanists, and have been again brought together by some modern ones under the Linnean name *Cynosurus*; but they appear to be sufficiently different in habit and character to be maintained as separate genera; and *Cynosurus* itself has two very distinct sections, raised by some to the rank of genera:—*Cynosurus* proper for the *C. cristatus*, Linn., and its annual Algerine variety *C. polybracteatus*, Poir., altered to *C. multibracteatus*, Rœm. & Schult. (*C. crista-galli*, Munby), in which the spike-like unilateral panicle

much resembles the spikes of Chlorideæ, and the glumes, though very pointed, are unawned; and *Falona*, Adans., altered by Dumortier to *Phalona*, for the *C. echinatus*, Linn., and *C. elegans*, Desf., with the panicle or head more like that of a *Dactylis*, but with awned glumes.

The characters of our fifth subtribe, *Eragrosteæ*, like those of Eufestuceæ, are chiefly negative. The two together comprise all the Festuceæ which have not the peculiarities of either of the other six subtribes, and differ from each other in the Eragrosteæ having three prominent nerves to the flowering glumes, the Eufestuceæ five or more nerves, sometimes rather obscure. Trifling as this character may be, it is a fairly constant one, the exceptional species being exceedingly rare; and I have found no other one so useful in distributing these numerous genera into groups. We have included in Eragrosteæ twelve of them, though the last of them (*Ectrosia*) might be equally well placed under the following subtribe Meliceæ.

28. Kœleria, Pers., has about twelve species, of which ten are European, temperate Asiatic, or North African, one of them extending over extratropical America north and south and South Africa; the two remaining species are endemic, one in South Africa, the other in the Sandwich Islands. The genus has been generally admitted with little variation; but it is difficult to assign to it any positive character. The panicle is usually dense and narrow, often spike-like; and the glumes are more scarious, especially on the margins, and have fainter nerves than in the others of the subtribe. It has been divided into two sections, maintained by some as genera:—1. *Airochloa*, Link, to which Reichenbach restricts the name of *Kœleria*, with the glumes obtuse or acute but without distinct points; and 2. *Lophochloa*, Reichenb., to which Link restricts the name of *Kœleria* (*Ægialitis*, Trin., altered by Schultes to *Ægialina*), in which the flowering glumes have a distinct point or short awn at or just below the tip. This section includes, besides the species enumerated by Cosson and Durieu in their 'Flore d'Algérie,' *K. Gerardi*, Munro, from South Africa, and *K. glomerata*, Kunth (*K. vestita*, Nees), from the Sandwich Islands. The last species differs slightly from the genus in the long loose panicle, which, however, is more dense in our specimens than it is figured by Kunth. C. Koch's genus *Wilhelmsia*, from the Caucasus, is, according to Grisebach, only a depauperated specimen of *K. phleoides*, Pers.

29. Avellinia, Parlat., is a single West-Mediterranean annual with the habit of *Schismus*, and placed by Savi in *Bromus*, by Gussone in *Avena*, and by DeCandolle in *Kœleria*. It is well marked amongst Eragrosteæ by the outer glumes, of which the lowest is almost reduced to a bristle, and the second broad, membranous, and the largest of the spikelet; the flowering glumes awned.

30. Eatonia, Rafin. (*Reboulea*, Kunth, *Colobanthus*, Trin.), two or three closely allied North-American species, with the second empty glume the largest of the spikelet, as in *Avellinia*; but the habit is very different and the glumes all unawned.

31. Dissanthelium, Trin. (*Phalaridium*, Nees, *Stenochloa*, Nutt.), comprises two, or perhaps three, species from the Andes of South America and the coasts of Mexico and California, figured and described in the last part of Hooker's Icones. They have most of the characters of *Schismus*, but, besides the widely distant geographical stations, they differ in the nerves of the flowering glumes always three, not five.

32. Molinia, Mœnch (*Enodium*, Gaudin), a single well-known European and temperate Asiatic species, and 33. Sphenopus, Trin., a very pretty little Mediterranean annual, require no further comment on the present occasion.

34. Catabrosa, Beauv., can only be distinctly characterized if reduced to the single *C. aquatica*, Beauv., placed by some authors in *Aira*, by others in *Glyceria*. In it the three nerves of the flowering glume characteristic of Eragrosteæ are very prominent. The two or three Oriental species added to it by Trinius belong to the genus *Colpodium*. *C. antarctica*, Hook. f., is a *Triodia*. *C. glaucescens*, Philippi, and *C. magellanica*, Hook. f., are true *Glyceriæ*.

35. Eragrostis, Beauv., an almost cosmopolitan genus of above eighty species (multiplied by Steudel and others to about two hundred and fifty), is a very natural one so far as the great majority of species are concerned, and distinctly limited if we include the three-nerved glumes amongst the essential characters. Yet in other respects there are exceptional species which have been variously referred, even by modern botanists, to *Poa*, *Festuca*, *Briza*, *Dactylis*, *Eleusine*, or *Leptochloa*, which they in some measure approach respectively; and some have been proposed as substantive genera; but it has appeared to me that the genus may be best defined if retained entire, dividing it into the six

following fairly distinct sections :—1. *Cataclastos*, Doell, includes *E. ciliaris*, Link, *E. peruviana*, Trin., and a few other tropical species, which, on account of their short spikelets with few flowers and fragile rhachilla, have been restored to *Poa* by Fournier and some others; but the shape and nervation of the glumes are quite those of *Eragrostis*, and the inflorescence, though peculiar, is not more that of *Poa* than of *Eragrostis*. *Macroblepharus* of Philippi, judging from his description, does not seem to differ from the true *E. ciliaris*. 2. *Plagiostachya* comprises some African and East-Indian species, which, with the flat several-flowered spikelets and continuous rhachilla of *Eragrostis* proper, have an inflorescence approaching that of Chlorideæ. The species are rather dissimilar in habit. *E. bifaria*, Steud., has the long simple terminal spike nearly of *Tripogon*, with obtuse glumes. *E. Schimperi* (*Harpachne Schimperi*, Hochst.) has a shorter simple spike and acuminate flowering glumes. *E. brevifolia* and *E. Cœlachyrum*, Benth., the latter forming the genus *Cœlachryum*, Nees, and figured in the last part of Hooker's Icones, have nearly the habit of some species of *Eleusine* (*Dactyloctenium*) or of *Æluropus*. *E. congesta*, Oliv., and *E. cynosuroides*, Roem. et Schultes, have very numerous short sessile spikelets crowded or clustered along the long terminal peduncle. 3. *Myriostachya* is an East-Indian species, *E. Wightiana* (*Leptochloa Wightiana*, Nees), allied to *E. cynosuroides*, but with a more complicated inflorescence. 4. *Pteroëssa*, Doell, or *Eragrostis* proper, is characterized by the usually many-flowered spikelets with the rhachilla continuous or rarely articulate when old, the flowering glumes usually deciduous, leaving the palea persistent on the minute floral axis with its back to the rhachilla. The species are numerous, and may be distributed into three rather distinct series:—*Cylindrostachyæ*, three or four Australasian species, with narrow-linear almost terete spikelets; *Leptostachyæ*, including the cosmopolitan *E. pilosa*, Beauv., and its allies, with narrow-linear flat spikelets; and *Megastachyæ*, including the widely-spread *E. megastachya*, Link, and many other, chiefly American, species, with broader linear or oblong flat spikelets. The generic name *Megastachya* has undergone many vicissitudes. It was first founded by Beauvois on the *Poa mucronata* of his Flora of Oware and Benin; but in drawing up the generic character for his 'Agrostographie' he had in view chiefly the common *E. megastachya*. Fournier, more recently, founded a genus on those American

species (*E. reptans* &c.) which have the spikelets more or less unisexual, the males usually flatter, longer, and with more flowers than the females; but this separation of the sexes is very variable, and not always accompanied by any difference in habit. Some species may be occasionally quite diœcious; in others the males and females are in different panicles on the same plant; others, again, are variously polygamous; and here, as in the Chilian *Poæ*, the character is too inconstant to justify generic or even sectional separation. *Megastachya*, Fourn., does not include *E. megastachya*, Beauv. 5. *Platystachya*, includes a few African or Arabian species with broad, flat, many-flowered spikelets with rather paleaceous glumes, and the rhachilla articulate as in *Cataclastos*. Amongst these Munro would include as *E. geniculata* the *Briza geniculata*, Thunb., which in its thickened spikelets appears intermediate between *Briza* and *Eragrostis*, but has the prominently three-nerved glumes of the latter. 6. *Sclerostachya*, has three African or Asiatic species. The paleaceous glumes and articulate rhachilla are those of *Platystachya*; but the spikelets are not so broad, and the rigid habit with long and rush-like or short and pungent leaves are those of *Æluropus*.

36. IPNUM, Philippi, is a single Chilian species unknown to me. From the author's description, it would appear to differ from the section *Pteroëssa* (*Cylindrostachyæ*) of *Eragrostis* in the articulate rhachilla and in inflorescence.

37. CUTANDA, Willk., is a genus proposed for the European or North-African *Festuca maritima*, DC., *F. philistæa*, Boiss., *F. memphitica*, Boiss., *F. divaricata*, Desf., *F. incrassata*, Salzm., and *F. lanceolata*, Forsk., which, notwithstanding a general resemblance to *Festuca* in the shape of the spikelets, could not remain in that genus without an essential alteration in its generic character, the glumes being strongly keeled and three-nerved from the base. The inflorescence is also peculiar.

38. OREOCHLOA, Link, is a single European mountain species, formerly included in *Sesleria*, which it approaches in its short compact inflorescence and the slightly elongated stigmas; but there are no barren spikelets, the spike is simple, with almost sessile bifarious spikelets like those of some species of *Festuca* (*Scleropoa*), and the glumes are those of Eragrosteæ.

39. ECTROSIA, Br., comprises three or four Australian species allied both to Eragrosteæ and to Meliceæ, but technically rather better placed in the former subtribe.

As a sixth subtribe, *Meliceæ*, I have collected five genera allied both to Eragrosteæ and Festuceæ, but technically connected with each other by their spikelets containing two or more empty glumes above the flowering ones. This character is also observed in *Ectrosia* and in *Lophatherum*, which I had formerly included in the group; but on other accounts the former appears better placed in Eragrosteæ, and the latter in Centotheceæ.

40. Cryptochloris, Benth., a single species probably from Patagonia, 41. Heterachne, Benth., two Australian species, and 42. Anthochloa, Nees, one or two species from the Andes of South America, are very distinct dwarf grasses, described and figured in Hooker's Icones.

43. Melica, Linn., contains above thirty species dispersed over the temperate regions of the northern hemisphere, and extending down the Andes into extratropical South America, represented also in South Africa. This genus, the typical representative of the subtribe, has been universally recognized since the days of Linnæus, and less tampered with than any other genus of equal extent, although it may be in some degree polymorphous in habit as well as in character. In the typical *Melicas*, however varied the panicle, long and narrow, or very loose and spreading, the spikelets are generally nodding or pendulous, with rarely more than two flowers; the flowering glumes more or less scarious on the margins and never awned, and the terminal empty glumes one within the other, form an obovoid obtuse mass. In a section proposed by Thurber for four North-west American species under the name of *Bromelica*, the spikelets are erect, with more rigid glumes occasionally awned and three to eight flowers, the upper empty glumes narrower and not so closely packed, giving the plants altogether so different an aspect, that I have much hesitated whether I should not, as suggested by Thurber, raise the section to the rank of a genus. In both sections the flowering glumes have five or more nerves. *M. stricta*, Boland., is in some measure intermediate between the two. *Chondrachyrum*, Nees, a Brazilian species which I have not seen, would seem from the description given to be a true *Melica*.

44. Diarrhena, Rafin. (*Korycarpus*, *Corycarpus* or *Rœmeria*, Zea, *Onoea*, Franch. and Sabat.), two species, one from North America, the other from Japan, is very near *Melica*; but the flowering glumes have only three nerves and are hardened round the grain, which usually exceeds them, and the stamens are reduced

to two or one. The habit is nearly that of the section *Bromelica* of *Melica*.

Our seventh subtribe *Centotheceæ* is formed of a small number of tropical grasses, several of which have been occasionally referred to Bambuseæ, but expelled from that tribe by all who have specially worked at it. The structure of the spikelet is that of some Eufestuceæ or Meliceæ; but the foliage is unusual, the lamina of the leaf is broad and flat, and between the numerous longitudinal veins are small transverse veinlets not observed in any others of the Order except in a few Bambuseæ. There is, however, none of that articulation of the lamina on the leaf-sheath which is almost universal in the latter tribe. The Centotheceæ comprise five genera.

45. Centotheca, Desv., has two or three species from the tropical regions of the Old World. They are tall grasses with a loose panicle, the spikelets awnless with usually more than two flowers, without any, or with only one empty glume above them. In the common *C. lappacea*, Desv., the flowering glumes have on their back a few reflexed rigid hairs or bristles; and that has been generally relied upon as the essential character of the genus; but the bristles are sometimes reduced to one or two minute tubercles, or even wanting, and in an African species (probably the *Poa mucronata*, Beauv.) there is no trace of them, and yet the plant is in all other respects an undoubted *Centotheca*.

46. Orthoclada, Beauv., is a single tropical-American species, with the habit, foliage, and inflorescence of *Centotheca*; but the spikelets contain only one, or rarely two, fertile flowers, the second flower being usually male only; the glumes have never the reversed bristles of *Centotheca*; and the spikelets appear to be frequently unisexual.

47. Lophatherum, Brongn. (*Acroelytrum* and *Allelotheca*, Steud.), has one, or perhaps two, species from tropical and Eastern Asia. The habit, foliage, and inflorescence are those of *Centotheca* and *Orthoclada*; but above the single fertile flower are several small empty, very shortly-awned glumes, densely crowded in a little unilateral tuft or crest, bringing the genus into connection with Meliceæ.

48. Streptogyne, Beauv., is a single species sparingly scattered over East India, tropical Africa and America, and the southern states of North America, allied perhaps in some respects to *Lophatherum*, but quite isolated in habit and a variety

of characters. The long narrow spikelets are few or numerous in a long, rigid, terminal unilateral spike; and the exceedingly long capillary styles become spirally twisted together far beyond the glumes. There is a considerable variety in the number of spikelets, in the number of flowers in each from one to four; and even the stamens and styles are sometimes two, sometimes three; but I have been unable to trace any connection of these diversities either with each other or with geographical stations so as to mark distinct species.

49. ZEUGITES, Schreb. (*Senitis*, Adans., *Despretzia*, Kunth, *Krombholtzia*, Fourn.), has five or six tropical-American species. They have not all the tall habit of the preceding genera; for the best-known West-Indian and Central-American species, originally described by Linnæus under *Apluda*, is a much weaker plant with smaller leaves; they are, however, broad and flat, with the characteristic venation of the subtribe. The spikelets in the genus generally have one fertile flower with two to five male ones above it.

I have already adverted to our eighth and last subtribe *Eufestuceæ*, or Festuceæ proper, as differing from Eragrosteæ in having five or more nerves to the flowering glumes instead of three or one only. Generally speaking, they have not the several-awned glumes of Pappophoreæ and Triodieæ, nor the barren spikelets nor long styles of Seslerieæ, nor the long hairs surrounding the flowering glumes of Arundineæ, nor the cluster of upper empty glumes of Meliceæ, nor the peculiar foliage of Centotheceæ; yet there are here and there exceptional species showing an approach to one or another of these characters, and interfering much with any definite line of demarcation. We include in the subtribe twenty genera, the last five of which are further characterized by the adherence of the grain to the palea; but, as already observed, this character is not quite constant even in *Festuca*, and is occasional in such genera as *Poa* and *Briza*, where the grain is usually free. I have been unable to discover any other character which would distribute the genera of the subtribe into more satisfactory groups.

The first two genera have a simple racemose inflorescence. 50. PLEUROPOGON, Br. (*Lophochlæna*, Nees), has three species, one arctic, the two others Californian, distinguished by the keels of the paleæ bearing a linear tooth or flat crest; and 51. BRYLKINIA, F. Schmidt, a single Japanese species, with two empty

glumes close under the flowering one besides the two lower persistent ones.

52. Uniola, Linn. (*Trisiola*, Rafin., *Chasmanthium*, Link), has four genuine North-American species, tall plants somewhat variable in inflorescence, but all with flat broad spikelets in which the three to six lower glumes are empty, but in size and shape pass gradually into the flowering ones, which vary from three to about twenty. If *U. racemiflora*, Trin. (*U. virgata*, Griseb.), from the West Indies, be retained in the genus as having flat spikelets with more than two empty glumes below the flowering one, it must be considered as a very exceptional species with the inflorescence nearly of *Leptochloa* among Chlorideæ. The small spikelets are closely sessile in two rows in unilateral spikes; and these spikes, shorter than in *Leptochloa*, are very numerous and crowded along the long peduncle. It would be better perhaps to regard the plant as a section of *Leptochloa* rather than as a distinct genus. Fournier has added three Mexican species of *Uniola* which are unknown to me; but, from his short characters, they would scarcely seem to be true congeners. *U. prostrata*, Trin., and its allies are now included in *Distichlis*.

53. Distichlis, Rafin., comprises four or five closely allied species, or perhaps varieties of a single one, extending from North America down the Andes to extratropical South America, one of them found also in Australia. They are generally, but not always, maritime plants, with few spikelets nearly sessile in a dense panicle, and generally if not always strictly diœcious, though the two sexes differ but little in habit. The glumes are rather rigid and paleaceous, which induced Link to join the only American species with which he was acquainted, with the Mediterranean *Poa sicula*, Jacq., as a genus *Brizopyrum*, a name retained by Presl and by Fournier for the American species. The European *B. siculum*, however, and some African congeners have the spikelets hermaphrodite, a more regular bifarious inflorescence, and otherwise differ sufficiently from the American forms to be maintained as a separate genus which has a primary title to Link's name.

54. Æluropus, Trin. (*Calotheca*, Spreng., *Chamædactylis*, Nees), has three species from the Mediterranean region, Central Asia, and East India, formerly included in *Dactylis*, but differing in their creeping or prostrate branching habit, short, rigid, often

pungent leaves, more numerous flowers in the spikelets, and some other minor points.

55. Dactylis, Linn., is now limited to two species:—the common and well-known *D. glomerata*, Linn., which from Europe and temperate Asia has spread over many parts of the civilized world; and *D. cæspitosa*, Forst., the celebrated Tussock grass of the Falkland Islands, which, though a much larger plant, appears to be strictly a congener.

56. Lasiochloa, Kunth, has three or four South-African species with a close almost spikelike panicle and hairy glumes, allied in many respects to *Kœleria*; but the inflorescence as well as the many-nerved glumes bring them nearer to *Dactylis*.

57. Brizopyrum, Link, as now understood, is specially founded on the Mediterranean *Poa sicula*, Jacq., to which are added three South-African species. The flat broad spikelets with coriaceous glumes are nearly those of *Eragrostis* sect. *Platystachyæ*; but the flowering glumes have seven nerves, and the spikelets are nearly sessile in a bifarious spike, or especially the lower ones closely clustered. I have already referred under *Distichlis* to the American diœcious plants for which the name *Brizopyrum* has been retained by Presl and by Fournier; the true *Brizopyra* are all hermaphrodite.

58. Sclerochloa, Beauv., is limited to the *S. dura*, a small Mediterranean annual well characterized by the inflorescence and shape of the glumes; the other species, sometimes referred to *Sclerochloa*, belong chiefly to *Cutanda*.

59. Briza, Linn., about ten species, of which the typical ones are chiefly European, though one has now spread over the greater part of the civilized world; two sections are entirely American, tropical or northern. All are characterized by the very concave, sometimes almost vesicular, glumes enclosing a much smaller broad flat palea, the grain much flattened from back to front, and sometimes, but not generally, adhering to the palea. The three best known European species have a very loose panicle with the spikelets hanging from capillary branches; the Oriental *B spicata*, Sibth., differs in its narrow closer panicle. The American species have been separated as two distinct genera, which may be retained as sections, though with little difference in essential characters. *Chascolytrum*, Desv., has the awnless spikelets of the European species; but the panicle, though branched, is much more compact, the

spikelets almost sessile. *Calotheca*, Desv., with a loose spreading panicle, has broadly scarious awned glumes.

60. Schismus, Beauv. (*Electra*, Panz., *Hemisacris*, Steud.), has three or four species, one of them widely spread from the Mediterranean region, eastwards to Afghanistan and Arabia and westwards to the Canary Islands, the others South African. All are annuals with a narrow panicle, and distinguished by the long empty glumes quite enclosing the flowering ones.

61. Nephelochloa, Boiss., limited to the original Oriental species, is a very elegant little grass with the habit of *Aira involucrata*, and is figured in the last part of Hooker's Icones. The species added to the genus by Grisebach, for which he was obliged to alter Boissier's character, are now restored to *Poa*.

62. Poa, Linn., is a cosmopolitan genus, chiefly extratropical, which, after frequent extensions and reductions, has now become fairly limited to a series of about eighty species. They form a group natural enough as to the great majority of species, differing from *Eragrostis* in their five-nerved flowering glumes, from *Glyceria* and *Festuca* in their glumes keeled from the base; but here, as elsewhere, there are species apparently intermediate between these large genera, and several smaller ones are only separated by characters of little importance. *Poa* has also been distinguished from *Festuca* by the obtuse, always unawned glumes, and by the non-adherence of the grain to the palea. The former character is general, but not absolute; several species of *Poa* have acute glumes, and in *P. lanuginosa*, Poir., they bear a fine point which might almost be termed a very short awn. And as to the grain, though it is usually free, there are several Chilian or Australian species and some Asiatic ones where it is adherent to the palea, as in *Festuca*, and even in the common *Poa pratensis* it is often more or less adherent, whilst there are several true *Festucas* where it is quite free.

Most of the widely spread species of this genus are so variable, that it would require much more research into specific detail than I can at present bestow upon them to distribute them into natural groups or sections; and I can only refer to the following as having been proposed as sections or separate genera:—*Pseudopoa*, proposed by C. Koch as a section of *Festuca*, includes *P. persica*, Poir., and two other temperate-Asiatic species, with very small spikelets and with nearly the habit of *Nephelochloa*, to which Grisebach has referred them, but which appear inseparable from

Poa notwithstanding the adherence of the grain to the palea. *Leucopoa*, Griseb., is the temperate-Asiatic *P. albida*, Turcz., with the spikelets rather larger than usual, and somewhat scariose and shining glumes like those of several Chilian species. *Dioicopoa*, E. Desv. (*Dispar*, Doell), is a section proposed for *P. chilensis*, Trin., *P. lanuginosa*, Poir., and their allies, in which the spikelets are usually, but perhaps not always, diœcious. In the dried state there is very little external difference between the male and the female panicle; and there are certainly Chilian specimens otherwise very near *P. chilensis* which have hermaphrodite flowers. Doell also places *P. lanuginosa* in his hermaphrodite section, whilst Emile Desvaux describes it as diœcious, as I have generally found it. The stamens, however, are very deciduous, and the ovary at the time the stamens are still enclosed very minute; and it requires careful observation to ascertain the real absence of the one or the other. It is probable that many species hitherto supposed to be perfectly hermaphrodite are more or less polygamous. *P. lanuginosa* shows, moreover, an approach to *Festuca* in the fine though short points to the flowering glumes, and in the adherence of the grain to the palea. *Poidium*, Nees, a Brazilian species, was separated by Nees from *Poa* on account of a reduction in the number of flowers to one or two, which Doell finds to be by no means constant.

63. Colpodium, Trin., about ten species, from the Levant and Russian Asia, might perhaps be regarded as a section of *Poa*. It differs in very little besides the small spikelets containing only one or two flowers, thus connecting *Poa* with the Agrosteæ. The arctic plant, published by R. Brown as a doubtful *Colpodium*, now forms Grisebach's genus *Arctagrostis*, included above under Agrosteæ.

64. Graphephorum, Desv., including *Scolochloa*, Link (*Fluminia*, Fries), and *Dupontia*, Br., contains seven North-American, North-European, or North-Asiatic species, very well worked up and distributed into four sections by Asa Gray. They are all very near *Glyceria*, differing chiefly in the hairs surrounding the flowering glumes, which induced several botanists to refer the genus to Arundineæ, though very different in habit and in the shape and venation of the glumes. The hairs of the spikelets are, moreover, very variable, shorter than in true Arundineæ, very short in the section *Arctophila*, and not entirely absent in one or two species of *Glyceria*.

65. Glyceria, Br., if we include *Atropis*, Rupr., is a genus of nearly thirty species spread over the extratropical regions, northern or southern, both of the New and the Old World. It is very nearly allied both to *Poa* and *Festuca*, differing from the former in the flowering glumes rounded at the base without any prominent keel, from *Festuca* in the broader more obtuse glumes, and the grain usually free from the palea, and from both in the shortness of the nerves of the glumes. The habit is somewhat variable, but as much so in each section as in the whole genus. The two sections into which it has been divided, often raised to the rank of separate genera, are:—1. *Hydrochloa*, Hartm. (*Porroteranthe*, Steud., *Exydra*, Endl., *Glyceria* proper of many botanists), with the lodicules connate and truncate or deficient, and the thick grain only marked on the inner face with a very narrow lined furrow or quite smooth; and 2. *Atropis*, Rupr. (*Puccinellia*, Parlat.), with two distinct lodicules and the grain more or less compressed from front to back, with a broad furrow or almost flat on the inner face. But these characters are not constant. The lodicules in the typical *Hydrochloa*, *G. fluitans*, Br., though thicker than in *Atropis*, and usually connate, are readily separable and occasionally spontaneously free; in *G. aquatica*, Sm., they are so short as to render it difficult to say whether they do or do not cohere, and in *G. nervata*, Trin., and in *G. pallida*, Trin., I can find no trace of them; in *Atropis* they are usually, but not always, more developed and thinner. The shape of the seed and of its furrow seems to vary from species to species, in so far as I have been able to procure it well ripened.

66. Festuca, Linn., is one of the genera as to whose limits botanists are the least agreed. With the exception of the exclusion of *Cutanda* and *Brizopyrum*, we have followed generally the arrangement proposed by Cosson and Durieu, which would include between seventy and eighty species (estimated by some at above two hundred and thirty), almost cosmopolitan in their geographical distribution, but most abundant in the northern temperate regions of the Old World, with not many American and very few tropical species. They are generally distinguished in the subtribe by the flowering glumes rounded without any prominent keel at least at the base, and acute or awned at the end, and by the glabrous grain adhering to the palea. But there are exceptions to each of these characters; and some species run very much into *Poa*, whilst others are scarcely distinct from *Bromus*. The

following are the most prominent groups established as sections or proposed by some as independent genera:—1. *Vulpia*, Gmel. (*Mygalurus*, Link), panicle narrow, dense, and usually unilateral, the outer glumes very unequal, one often minute or almost obsolete, the flowering glumes awned, and frequently, but not always, only one stamen. If we had only the common European species, this might well have been kept up as a genus; but in the South-American *F. ulochæta*, Doell, and *F. leptothrix*, Trin., the panicle is loose, as in *Eufestuca*, and in *F. delicatula*, Lag., *F. setacea*, Parlat., the awn is sometimes very short and the inflorescence rather that of *Eufestuca*. The proportions of the outer glumes vary from species to species. 2. *Eufestuca*, comprises the greater number of the species, with a loose, spreading or narrow panicle, the outer glumes nearly equal, the flowering ones acute or mucronate, rarely short-awned, and three stamens. Amongst them Grisebach has distinguished a section *Phæochloa*, with the ovary slightly hairy at the top as in *Bromus*; but the character is very variable in *F. sylvatica*, *F. varia*, and their allies. Doell has proposed a section *Mallopetalum* for the Brazilian *F. ampliflora*, Doell, apparently the same as the Mexican *F. amplissima*, Rupr., characterized by the lodicules villous at the top. I find these lodicules fringed with long hairs at the top exactly as in *F. fimbriata*, Nees, which Doell places amongst his *Festucæ legitimæ* with glabrous lodicules. *Helleria*, Fourn., is proposed as a genus for the Mexican *Bromus lividus*, H. B. K., which Sprengel afterwards and Kunth himself removed to *Festuca*, of which it has all the characters of the awned species. The inflorescence is at first very like that of some varieties of *Bromus tectorum*; but as it advances the spikelets become very much divaricate or reflexed, giving the plant a peculiar habit. 3. *Schedonorus*, Beauv. (*Amphigenes*, Janka), comprises *F. pratensis*, Huds., *F. sylvatica*, Host, *F. nutans*, Host, *F. littoralis*, Labill., *F. Hookeriana* and *F. scirpoidea*, F. Muell., and a few others, tall plants, with loose, narrow or spreading panicles, awnless glumes, and the grain quite free from the palea, thus connecting the genus with *Poa*. Fries and other Swedish botanists, whilst they rightly referred Beauvois's species of *Schedonorus* back to *Festuca*, transferred his generic name to a very different group, which now forms the sections *Festucoides* and *Stenobromus* of *Bromus*. 4. *Catapodium*, Link, including *Micropyrum*, Link, differs from *Eufestuca* in the inflorescence, which is nearly the simple spike of Hordeeæ; but the

rhachis is not notched and the spikelets are not quite sessile, the lower ones often two or three together on a very short branchlet, not collateral. *Nardurus*, Reichb., is the *F. unilateralis*, Schrad., differing from the rest of the section in the flowering glumes mucronate or shortly awned. *Castellia*, Tineo, is the *F. tuberculata*, Coss. and Dur., in which the flowering glumes are minutely tuberculate and the spike often shortly branched. *Nardurus montanus*, Boiss., scarcely differs from *F.* (*Vulpia*) *delicatula*, Lag., and *F. cynosuroides*, Desf., is also referable rather to *Vulpia* than to *Catapodium*. *F. lolium*, Balansa, may really be said to be intermediate between *Festuca* (*Catapodium*) and *Lolium*. *F. unioloides*, Kunth, is *Brizopyrum siculum*. *Catapodium fusiforme*, Nees, is *Tripogon bromoides*, Nees. 5. *Scleropoa*, Griseb. (*Sclerochloa*, Reichb., not of Beauv.), annuals, often small, with one-sided panicles, the short rigid branches bearing few almost sessile spikelets, at first erect, then spreading or reflexed, giving nearly the habit of *Cutanda*, but the glumes entirely those of *Festuca*.

67. PANTATHERA, Philippi, and 68. PODOPHORUS, Philippi, are monotypic genera from the island of Juan Fernandez, both very near *Bromus*, but scarcely reducible to it.

69. BROMUS, Linn., is a fairly natural genus of about forty species, generally distributed over the temperate regions of the northern hemisphere, with a very few tropical or southern species. Very near *Festuca*, with which it is closely connected through *Festuca gigantea*, Vill. (*Bromus giganteus*, Linn.), it differs generally in the flowering glumes distinctly notched or shortly two-lobed at the end, with an awn between the notches often not quite terminal and sometimes slightly twisted, showing an approach to *Avena*, and in the grain (always adnate to the palea) crowned by a little appendage or tuft of short hairs. These characters are, however, not quite constant; and the four following sections into which the genus has been divided run also much into each other, though some of them are often regarded as separate genera:—1. *Festucoides*, Coss. and Dur. (*Schœnodorus*, Griseb.), consists of *B. asper* and *B. inermis*, Linn., *B. erectus*, Huds., and their allies, tall perennials, coming nearest to *Festuca*, with the awns usually very short or reduced to small points. 2. *Stenobromus*, Griseb. (*Anisanthe*, C. Koch), mostly annuals, with narrow spikelets and long-awned glumes. *Schedonorus* of Fries and other Swedish botanists, but not of Beauvois, includes both *Festucoides*

and *Stenobromus*. 3. *Zeobromus*, Griseb. (*Serrafalcus*, Parlat.), spikelets usually broad and thick, the flowering glumes awned, and the nerves of all the glumes more numerous than in the preceding sections. *Libertia*, Lejeune (*Michelaria*, Dumort.), is the *B. ardennensis*, Kunth, differing from *B.* (*Zeobromus*) *secalinus* in the lateral lobes or teeth of the flowering glumes produced into slender points or very short awns. *Triniusa*, Steud., is the *B. Danthoniæ*, Trin., very near *B.* (*Zeobromus*) *macrostachyus*, Desf.; but most of the flowering glumes, especially the upper ones of the large spikelets, bear three long recurved awns. 4. *Ceratochloa*, DC. (or Beauv.), three or four American species, extratropical or Andine, with flat spikes not unlike those of *Uniola*, but at length often thickened as in *Zeobromus*, and the flowering glumes scarcely notched at the end, and the awn very short. Fournier rightly retains the *B.* (*Ceratochloa*) *purgans*, Linn., in *Bromus* (under the name of *B. Hookeri*), but keeps up the genus *Ceratochloa* for the original *C. unioloides*, DC., as having the lodicules connate. I have examined a number of specimens, both wild and cultivated, and have always found the lodicules attached by a broad base and contiguous, but quite free or only exceedingly shortly cohering at the very base.

70. Brachypodium, Beauv. (*Hemibromus*, Steud.), has five or six European or temperate-Asiatic species, one or two of which are also in Mexico, Colombia, and tropical and southern Africa. They closely connect *Festuca* with *Agropyrum*; the spikelets are those of the former though usually longer, and the simple spicate inflorescence is that of *Agropyrum*, except that the rhachis is not articulate and not at all or scarcely notched, and the spikelets are not so closely sessile, usually few and distant. *Trachynia*, Link, is *B. distachyum*, Roem. and Schult., which differs from the rest of the genus as an annual, with only one or two spikelets at the end of the peduncle.

Tribe XIII. Hordeeæ.

This tribe, one of the most definite of the Poaceæ, is characterized chiefly by the inflorescence. The spike is always simple, except in abnormally luxuriant cultivated varieties or monstrosities, the rhachis notched and often, but not always, articulated, the spikelets (one- or several-flowered) singly or two or more collaterally sessile at each notch. The genera, mostly very distinct, belong to the temperate regions of the New as well as the

Old World, chiefly in the northern hemisphere; and scarcely any species, except as introduced weeds or escapes from cultivation, penetrate within the tropics. The twelve genera are readily ranged in three distinct subtribes, and require but little comment on the present occasion.

The first subtribe, *Triticeæ*, comprises four genera, in which the spikelets have three or more, or very rarely only one or two, flowers, and are singly sessile at each notch of the rhachis.

1. Lolium, Linn., is at once distinguished from all others of the tribe by the position of the flat spikelets with their edge to the rhachis. Steudel enumerates twenty-two species; most authors reduce them to three or four, which run much into each other. De Rouville published at Montpellier a detailed monograph, in which he rejects all the old species and redivides the genus into three primary and several subordinate races, to which he gives new characters and new names, doing little but add to the prevailing confusion. Two genera have been founded on individual species or forms—*Cræpalium*, Schrank, is the *L. temulentum*, Linn., and *Arthrochortus*, Lowe, is a Madeiran species or variety very near to *L. rigidum*, Gaudin (*L. strictum*, Parlat.), and to some varieties of *L. temulentum*.

2. Agropyrum, J. Gærtn. (*Elytrigium*, Desv.), contains about twenty species, formerly regarded as congeners of the cultivated Wheats, from which they differ much in habit and technically in the lateral nerves of the flowering glumes connivent at the top or confluent into the terminal awn. They are well distributed into two sections:—1. *Agropyrum* proper, mostly perennials, with the spikelets more or less distant along the common peduncle or rhachis, the outer empty glumes usually very unequal-sided and not keeled. To this section belong the common *A. repens*, *A. junceum*, *A. caninum*, and a few others. *Rœgneria*, C. Koch, is, according to Grisebach, a species closely allied to *A. caninum*. *Anthosachne*, Steud., is the Australasian *A. scabrum*, Beauv. (*Festuca scabra*, Labill.), which, with the closely allied East-Indian *A. semicostatum*, Nees, and the Oriental *A. longearistatum*, Boiss., differs from the commoner species in the denser spikes and narrower glumes tapering into long awns at length diverging. *A. pectinatum*, Beauv., is an Australian species still further connecting *Agropyrum* proper with *Eremopyrum*. 2. *Eremopyrum*, Ledeb. (*Cremopyrum*, Schur, perhaps by a clerical error, *Costia*, Willk.), mostly annuals, with the spikelets distichous

and close together in a short dense spike, the narrow empty glumes nearly equal-sided and keeled. Two species, *A. villosum* (*Secale villosum*, Linn., *Haynaldia*, Schur) and *A. hordeaceum*, Boiss., form the proposed section *Dasypyrum*, Coss. and Dur. (*Pseudosecale*, Gren. and Godr.), differing slightly from the other species in the empty glumes rather unequal-sided, and one lateral nerve on one side of the keel very frequently as prominent as the keel itself, giving the glume the appearance of being two-keeled. *Heteranthelium*, Hochst., from the Levant, is a species very near *A.* (*Eremopyrum*) *orientale*, with a dense villous spike, and several of the spikelets, especially near the base and apex of the spike, often sterile with empty glumes.

3. Secale, Linn., is now reduced to two species or perhaps varieties, the cultivated Rye, of which *S. montanum*, Guss., is supposed to be the original spontaneous form, and *S. fragile*, Bieb. The genus differs slightly from the section *Eremopyrum* of *Agropyrum* in the dense cylindrical spike, and in the spikelets usually containing only two flowers.

4. Triticum, Linn., excluding *Agropyrum* and including *Ægilops*, can scarcely reckon more than ten botanical species; the most prominent character separating them from *Agropyrum* consists in the shape of the spikelets not so flat, and especially in the lateral nerves of the flowering glumes not connivent, but remaining parallel or nearly so, and either stopping short of the apex or produced beyond it into distinct teeth or awns. There are three rather distinct groups:—1. The cultivated *Wheats*, of unknown origin, in which the flowering glumes are keeled at the end and sometimes from the base, and terminate in a single awn, the lateral nerves usually barely reaching to the end of the glume. 2. *Crithodium*, Link, founded on *T. monococcum*, Linn. (*T. bœoticum*, Boiss.), in which the spikelets have only one fertile flower, and the flowering glume is keeled from the base and ends in a single awn. *T. bicorne*, Forsk., with two or even three fertile flowers and the lateral nerves of the flowering glumes sometimes produced into short teeth, may be referred to the same section. 3. *Ægilops*, Linn., above forty published species, which Munro reduces to seven or eight, differing from the cereal wheats in the flowering glumes more rounded at the back and not at all keeled, and in the lateral nerves of the flowering glumes often produced into long awns, especially in the upper end of the spike. The

extreme readiness with which some species hybridize with the cultivated wheats has given rise to the suggestion, strongly advocated by some, positively rejected by others, that it is in some of the common species of *Ægilops* that we must look for the original of our cereal wheats.

The second subtribe, *Leptureæ*, is characterized by the slender spikes and the spikelets solitary at the notches, each with only one or rarely two flowers. We refer to it five genera, placed by Kunth and some others in Rottboellieæ, from which they differ in the outer empty glumes, when present, persisting below the articulation of the rhachilla.

5. Lepturus, Br., including *Pholiurus*, Trin., has six species, five of them with the ordinary geographical range of the tribe, the sixth, *L. repens*, Br., exclusively Australasian or South Pacific and maritime. They are distinguished in the subtribe by the rigid outer empty glumes, one or two in number, much longer than the hyaline flowering glume, thus showing the nearest approach to Rottboellieæ. They differ from each other sufficiently to have been referred by different botanists to different genera. *L. cylindricus*, Trin. (*L. subulatus*, Kunth), included by Link in *Ophiurus*, by Reichenbach in *Monerma*, has one outer empty glume and one flower with no empty glume above it. The Australasian *L. repens*, a much larger plant than any of the others, has one outer empty glume, one flower, and above it a glume either empty or enclosing a palea, but no flower. *L. persica*, *L. incurvata*, and *L. filiformis*, Trin., have two lower empty glumes, one flower, and no empty glume above it. *L. pannonicus*, Kunth, forming Trinius's genus *Pholiurus*, and referred by T. Nees to *Ophiurus*, has two outer empty glumes and two perfect flowers.

6. Psilurus, Trin. (*Monerma*, Beauv., partly, *Asprella*, Host but not of Willd.), is a single annual, near *Lepturus*, but with only one minute empty glume, a single narrow and awned flowering glume, and only one stamen in the flower.

7. Nardus, Linn., is a single well-known small perennial, the position of which in the system is rather puzzling. The spikelet has only one flower without any empty glumes below it or prolongation of the rhachilla above it, which might have decided its relationship either to Panicaceæ or to Poaceæ, and its long simple style might indicate an affinity to some Paniceæ or to Seslerieæ; but on the whole it seems nearest allied to the Lepturææ, a supposition which might be confirmed, if we regard the rather pro-

minent lower margin of the notches of the rhachis as a rudimentary glume.

8. Kralikia, Coss. and Dur., is a single Algerine species unknown to me, but well described, and evidently rightly placed in the present group. 9. Oropetium, Trin., is a dwarf East-Indian species remarkable for the cylindrical spike, with perfectly immersed spikelets as in some *Rottboellias* and *Ophiurus*, but with the outer persistent glumes of Hordeeæ.

The third subtribe *Elymeæ* comprises three genera, in which the spikelets are two or more, collaterally sessile at each notch of the spike, or the lateral ones very shortly stipitate.

10. Hordeum, Linn., was restricted by Beauvois to the common cultivated barley, *H. vulgare*, Linn., which in a great variety of forms is of very ancient cultivation, and whose indigenous origin is no more known than that of our wheats. Amongst these forms the East-Indian *H. ægiceras*, Royle, has been proposed by E. Meyer as a genus under the name of *Critho*; but it cannot be otherwise considered than as a luxuriant monstrosity. The really spontaneous species of *Hordeum* amount to about twelve, distinguished from *Elymus* by the single flower in each spikelet, and distributed into three sections:—1. *Zeocriton*, Beauv. (*Critesion*, Rafin.), for the *H. murinum*, *H. bulbosum*, *H. jubatum*, Linn., and some others, in which the central spikelet alone of each three is fertile, the lateral ones sterile or reduced to empty glumes; 2. *Crithopsis*, Jaub. and Spach (sect. *Medusather* of *Elymus*, Griseb.), for the *H. crinitum*, Desf., and its allies, with two perfect spikelets at each notch, the intermediate one deficient or rarely represented by one or two empty glumes; 3. *Cuviera*, Koel., for the *H. sylvaticum*, Huds. (*Elymus europæus*, Linn.), with three collateral spikelets.

11. Elymus, Linn., as now generally limited, comprises about twenty species, distributed into three sections, all distinguished from *Hordeum* in having two or more flowers to each spikelet:—1. *Sitanion*, Rafin. (*Polyantherix*, Nees), for the North-American *E. Sitanion*, Schult., with the flowering glumes usually three-awned; 2. *Clinelyna*, Griseb., with the spikelets usually two only to each notched and the flowering glumes with one long awn; and 3. *Psammelyna*, Griseb., tall rigid species with often more than two spikelets to each notch, and the flowering glumes unawned or with only very short awnlike points.

12. Asprella, Willd. (*Hystrix*, Moench, *Gymnostichum*, Schreb.), has three species, of which two are North-American, the third from New Zealand. There are two or three collateral spikelets to each notch as in the preceding genera; but the outer empty glumes are entirely deficient, except sometimes one or two slender ones to the lower spikelets of the spike. Willdenow's name has the priority over Schreber's; for although the Beschreibungen of the latter author bears the date 1769 on the titlepage, the third part, in which the present genus was proposed, was only issued in 1810.

Tribe XIV. Bambuseæ.

The Bamboos have been so admirably monographed by Munro in the twenty-sixth volume of the Linnean 'Transactions,' that I have very few notes to make on the present occasion. Since the appearance of that memoir, Balansa has published a New-Caledonian Bamboo forming the distinct genus *Greslania*; a further acquaintance with *Thamnocalamus* has induced its reunion with *Arundinaria*; and, on the other hand, *Merostachys capitata*, Hook., is so very different in inflorescence from the rest of the genus, that I have proposed to separate it under the name of *Achroostachys*. I have also proposed as a new genus *Melocalamus*, the *Pseudostachyum compactiflorum*, Kurz, published since Munro's monograph. There is also much confusion in the generic term *Beesha*, which, though used by Rheede for a Peninsular species of Bamboo, was first characterized by Kunth chiefly from the more eastern *Bambusa baccifera*, Roxb., now *Melocanna bambusoides*. He did indeed also include the Peninsular and Ceylon species; but that was first properly characterized as a separate genus by Thwaites, under the name of *Ochlandra*, which it seems advisable to adopt, though the genus may include Rheede's *Beesha*, a name which it seems best to consider only in the specific sense first given to it.

Report on the Arctic Drift Woods collected by Captain Feilden and Mr. Hart in 1875 and 1876. By W. R. M'NAB, M.D., F.L.S., Professor of Botany, Roy. Coll. of Science, Dublin.

[Read November 3, 1881.]

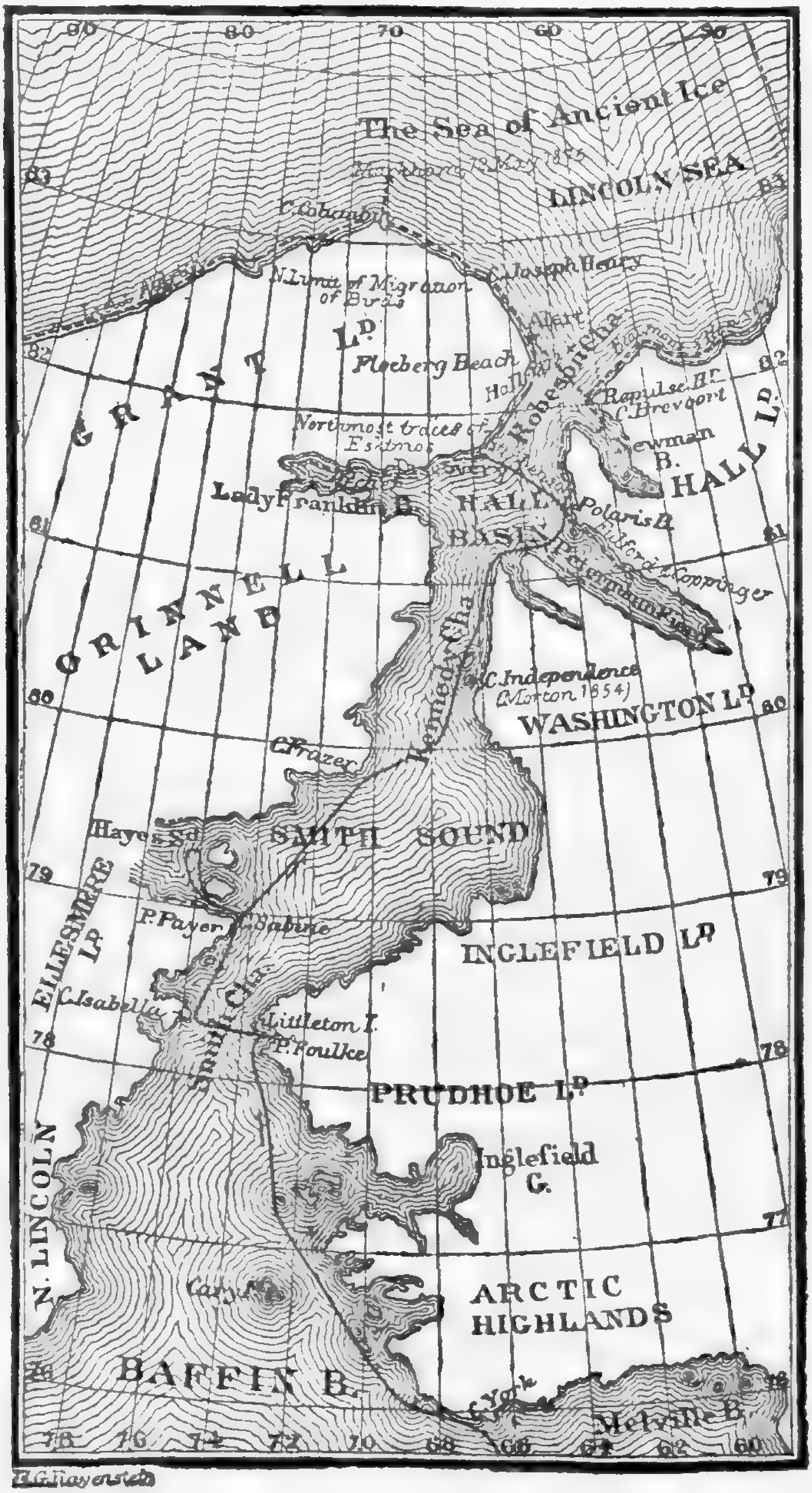
IN the following Report I have endeavoured to detail the results of my examination of the drift woods brought from the Arctic regions by the naturalists attached to the recent Arctic expedition under Captain Nares. There are thirteen specimens of drift wood and one specimen of bark, collected in different localities by Captain Feilden and Mr. Hart; and these were placed in my hands for examination by Professor Oliver, F.R.S. The specimens of wood are all completely devoid of bark; hence it was impossible to distinguish the genus to which some of the Coniferous woods belong, as, for example, *Picea* and *Larix*, the genera to which most of the woods may be referred. In general the woods were well preserved and in good condition, except on the very surface; hence there was little difficulty in obtaining proper sections for microscopic examination. The woods were all cut in three directions, as is usual in examining dicotyledonous and coniferous woods; and the sections were viewed both dry and when mounted in Canada balsam. Careful comparison of the drift woods with sections of named woods has not enabled me to identify the species in any case; hence the whole of the results obtained must be considered unsatisfactory. In the following list the specimens are lettered A to O, the letters &c. corresponding to the labels on the slides of the preparations accompanying the Report*.

1. PINUS sp. (One species.)

Two portions of wood are referable to *Pinus*. These I have indicated by the letters A and B. Both the pieces in the collection are marked as from the same locality, viz. "Head of Discovery Bay, April 1876," but one of them (B) as having been "100 yards from the water, embedded in sand." The woods are quite similar in outward appearance, and are portions of comparatively large

* I have also examined a small collection of drift woods made by Staff-Surgeon Edward L. Moss, M.D., R.N., Surgeon of the 'Alert.' His specimens are similar to those obtained by the naturalists of the Expedition, with one exception, viz. a portion of a stem of a species of *Juniperus*. The stem must have been of some size, and belongs apparently to a North-American species.

trunks or branches. The central portions of the stem are well preserved; but the outer part is soft and partially destroyed. A has well-developed annual rings, some of the rings near the periphery of the stem being, however, small and feebly developed, thus indicating a deficiency in growth. The wood of B presents the same general characters; and I am inclined to consider them portions of the same species of *Pinus*, if not parts of the same tree.



Sketch Map showing the route of the late Arctic Expedition between the parallels 78°–83° N. lat., with the localities generally where the drift woods were obtained.

2. Abies sp. (One species.)

One piece of wood of small size; but probably a portion of a larger stem cut and rounded by man, belongs to the genus *Abies* (C). By comparison with other sections, it seems to come very close to *Abies pectinata*. The specimen is marked "Discovery Bay, 20 feet above sea-level, Aug. 1875, Captain Feilden." The annual rings of wood are large and well developed.

3. Picea or Larix. (Three species.)

Seven pieces of drift wood are to be referred to one or other of these genera; but, owing to the absence of the bark, it is impossible to decide definitely. One of the specimens (D) comes very near *Larix*, and differs from all the other woods in the collection.

? Larix sp. This is the specimen D, marked "Dumb-bell Harbour." The stem has been large, and is well preserved, and, by comparison with named sections of *Larix*, seems to come very near *L. europæa*.

? Picea sp. Two specimens seem to belong to one species, viz. E, "Label incomplete. Upon Floe. Sept. 12, 1875," and F, "On Floe, lat. 82° 30′ N. Capt. Feilden." These are portions of well-preserved woods, white and firm, and having the same microscopical characters. They are probably not portions of the same stem, as I believe E is almost certain to be from Mr. Hart's collection, while F is Captain Feilden's. The annual rings are well developed in both specimens.

? Picea sp. Four specimens. G, H, J, K. All similar in microscopic character, and belonging either to *Picea* or *Larix*.

(G) "1 mile inland and 150 feet elevation at 'Alert' winter-quarters, Feb. 1876. Captain Feilden." This piece of stem has well-developed annual rings.

(H) "Drift wood. Bottom of Musk-ox Fjord. Sept. 16, 1875." 35·5 inches long, 16 in circumference. Portion of a large stem with well-developed annual rings.

(J) "No. 1. No locality nor date." A small piece of very much waterworn drift wood with well-developed annual rings, and probably a portion of a large stem.

(K) "No. 1009. No locality." Small portions of a large stem in a good state of preservation, and having well-developed annual rings.

Picea sp. Bark only. The specimen (L) is from pieces of bark evidently of a *Picea*, and marked "On floe in Dumb-bell Bay,

Sept. 1875. Found by Commander Markham." It is not improbable that this may be the bark of the commonest drift wood, and may therefore help to identify the genus of the six specimens of wood just described.

4. Taxus sp. (One species.)

A single sample of very much waterworn pieces of drift wood, which have probably been embedded in mud, is referable to the genus *Taxus*, having the spiral markings clearly shown in the wood prosenchymatous cells. It is marked M, "Out of cloth bag; no locality." The annual rings are extremely imperfect and very numerous.

5. Populus sp. (One species.)

Two pieces of drift wood are to be referred to *Populus* (near *tremula*), and are interesting as being the only species of dicotyledonous wood in the collection. One of the specimens (N) is marked "Drift wood. Musk-ox Bay. Sept. 1875;" and the other (O), "East Cary Island. Capt. Feilden." The former is a portion of a large stem, and is in an excellent state of preservation, while the latter is equally well preserved, but is only a part of a small branch. In both of the woods the annual rings are well developed.

Of the 14 specimens submitted to me for examination, 13 are samples of wood, and 1 is of bark alone without any trace of wood, the bark being evidently coniferous and to be referred to the genus *Picea*. Of the 13 woods, 11 are coniferous, and only 2 dicotyledonous, both belonging to the same genus, *Populus*, and to the same species.

The 11 coniferous woods belong to four, or perhaps five, genera, there being 1 species of *Pinus*, 1 of *Abies*, 1 of *Larix* ?, 2 of *Pinus* or *Larix*, and 1 of *Taxus*. Of *Pinus* there are 2 specimens, of *Abies* 1, *Larix* or *Picea* 7, and *Taxus* 1—the commonest form being some kind of *Picea*, probably an American Spruce.

I have not been able to identify the species, but, from careful comparison of specimens, am inclined to think that most of them are North-American; and as the annual rings are usually very well developed, the trees must have grown in the more northern temperate latitudes.

On the Flora of the Kuram Valley, &c., Afghanistan.—Part II.

By J. E. T. Aitchison, F.L.S., Surgeon-Major H.M. Bengal Army.

[Read June 16, 1881.]

(Map, with Plates I.–XXX.)

General Observations.

In continuation of my paper (see vol. xviii. pp. 1–113) "On the Flora of the Kuram Valley," I have the honour now to lay before the Society the results of my further researches in that country during 1880. I regret to say that, although I landed in Bombay on the 1st of March, I was unable, owing to the delay caused in waiting for orders from Government, to commence work at Kuram until the 29th of May, at which date I was far too late for the spring vegetation. I proceeded to Kuram with the expectation that some of the troops would almost certainly cross, *viâ* the Shútar-gardan Pass, to Kabul, and that I should thus be able again to investigate that part of the country which already had proved so prolific in new types. None of the Forces, however, from the Kuram valley crossed the passes towards Kabul, nor was the Hariáb district occupied by our troops during the season, with the exception of the Péwár-kotal. Owing to these circumstances, my collections are not nearly so rich as last year's. I was, however, able to botanize some portions of new country with tolerably satisfactory results, obtaining several new species, and adding considerably to the material of many of the more interesting species of my last year's collections. Had more time been placed at my disposal, I should have been able to lay before the Society some further particulars respecting the geographical range of the more interesting species, illustrated by a set of analytical tables. I still hope, however, to be able at some future date to communicate this information.

I here beg to thank all my friends at Kew for the assistance they have given me—Professor Oliver, Mr. Baker, who this year has again identified and named my Leguminosæ and petaloid Monocotoledons, Mr. C. B. Clarke, whose time I have so frequently broken in upon, Mr. Brown, and Mr. Hemsley, without whose

assistance, especially in the descriptions of the new species, the work could not have been completed so thoroughly and at such an early date.

The new ground I went over includes:—the low hills in the vicinity of Shinak and the country between that and Badish-khél, up to an altitude of over 5000 feet; similar hills to the south of the Kuram river, opposite Kuram; the valleys of the Zérán and Malána streams, up to their respective passes on the Saféd-koh range; the valley of the Darbán river, which is the eastern tributary of the Shálizán stream; and, lastly, some ground at the western base of Mount Síka-Rám towards the Tarúkí-Kanda pass. During August and September I twice travelled over the subtropical region, viz. the portion of the country between Thal and Badish-khél, which gave me a further insight into its flora than it was possible for me to obtain last year.

Vegetation between Thal and Badish-khél.

Dalbergia Sissoo is common as a good timber-producing tree along the banks of the Kuram, as well as its numerous tributaries, as far north as the village of Jelamai, at the base of Mount Kákúta, and is certainly indigenous to the country. It is also seen as a protected, or even planted, tree at holy shrines and ziarets. I saw no specimens of either *Phœnix sylvestris* or *P. dactylifera* at Thal or beyond it northwards. *Ephedra ciliata*, a semiscandent shrub, the main stem of which has very peculiar lozenge-shaped markings, grows up through trees of 12 to 16 feet in height; it then spreads out its branches, hanging over the tree upon which it is scandent until it quite hides its support. It is usually diœcious; but female fertile flowers frequently occur amongst the staminate ones. *Periploca hydaspidis*, by no means common in this country, simulates *Ephedra ciliata* so closely that, unless there is flower or fruit by which to distinguish it, I should say that even museum-specimens of the two plants might easily be mistaken for each other. At Alizai I succeeded in procuring for the Museum at Kew a branching specimen of *Nannorrhops Ritchieana*, which I should not have been able to convey away, had it not been for the assistance I received from Lieut. F. Beauclerk, R.E., whom I here thank. The pro-

Branching stem of *Nannorrhops Ritchieana*, Wendl., from a specimen in the Kew Museum. Drawn to scale half an inch to the foot.

duction of branches by this palm is due, I believe, to the arrest of the large inflorescence. When one sees this palm as a tree 20 feet in height, and then in a branching condition (see woodcut), one can scarcely believe it to be the same species as that found in such a stunted, miniature state on Mount Tilla, in the Salt range, where also it is indigenous. Creeping over the palm (*Nannorrhops*) scrub, *Zehneria umbellata* is a very characteristic plant, remarkable for its extremely varied form of leaf. It is common all over India, and is enabled, no doubt, to live here through the rigorous winters from the protection its perennial root-stocks receive under the shelter of the dense palm-cover. Among the low shrubs on the Conglomerate formation I picked up a new species of *Teucrium*, a woody shrub about 2 feet in height, that seems very common, but which was difficult to find in flower. Near Shinak, *Buxus sempervirens* is found in some quantity as a large dense shrub, its wood being employed in making the bowls of pipes. I managed to procure a couple of pipes, one of which is fairly carved. Here I was informed that the old wood of *Rhus Cotinus* is used as a dye for wool-stuffs, chiefly used in making felts of an orange-red colour. In this part of the country, like *Edwardsia mollis* in the Kuram and Hariáb districts, the young leaves of *Adhatoda vasica* are largely collected and mixed with the grain in the rice-nurseries to hasten the process of germination by the heat generated during their decomposition. In writing of *Edwardsia*, I may just mention that I noticed in a paper lately read before this Society by Dr. Watt the following

statement:—"It is a remarkable fact that every plant exhibited the peculiarity of bearing an abundance of long filiform outgrowths proceeding from various parts of the plant." I have also found these growths to be present in nearly all the specimens of the plant in the Herbarium at Kew; and I have scarcely ever collected it without its being thus affected. On examination, these growths prove to be a form of gall, produced by the deposition of the ova of some insect whilst the leaves or fruit are in a very young state. This malformation is represented by a somewhat analogous condition in the horn-like processes developed on *Pistacia integerrima*, J. L. Stewart (Royle's specific name, *Kakrasingee*, for the gall-bearing condition of this species, signifies wild-sheep's horn)—and also again in Wallich's *Cerasus cornuta*, which has been identified as *Prunus Padus*, Linn.

The Grasses met with were nearly all species procured in the Punjab, and of the following genera:—Growing near water, *Arundo*, *Phragmites*, *Hemarthria*, *Saccharum*, and *Panicum*; in the dry stony country, *Gymnothrix*, *Pappophorum*, *Aristida*, *Chrysopogon*, *Andropogon*, *Heteropogon*, *Elionurus*, and *Pennisetum*. Those considered the best fodder grasses were *Panicum sanguinale* and *Panicum pabulare*, a new species, much collected by the villagers for their cattle, said to be superior to all. *Fingerhuthia africana*, Lehm., a very remarkable grass, heretofore only found in South Africa, occurs in luxuriance at the end of August or beginning of September, depending on the rainfall; it is a very pretty grass, in general habit resembling *Phalaris minor*, which is found in the Punjab, and some of the European species of *Phleum*. In the hills, both near Shinak and to the south, opposite Kuram, I collected an undescribed species of *Statice*, viz. *S. Griffithii*, not handsome in its flower, but curious in the way it throws out buds from an underground perennial rhizome. At, and a little above, 5000 feet I collected *Quercus Ilex*, *Olea*, *Rhus* (two species), *Rhamnus persica*, *Dodonæa*, *Reptonia*, and *Buxus*. I sought for *Pinus longifolia*; but it does not appear to exist anywhere in the Kuram valley that I have explored; and I am of opinion that it is not to be found in Afghanistan, and in all probability not to the north or west of the Indus, except cultivated. I doubt if it was really this species that is mentioned by Dr. Stewart as having its lower limit at 9000 feet in the Sulimán

range. There are no Afghanistan specimens from Griffith in the herbarium at Kew. The specimens of the cultivated tree collected by him in a garden at Kándahár, and so named, belong to *Pinus halepensis*. Furthermore, it is extremely doubtful if the pine he speaks of as growing on the ridges of Káfristán at 6000 feet could possibly have been *P. longifolia*.

Vegetation between Badish-khél and Habíb-kalla.

Up to this point I had noticed that every native when drinking from a spring of water, usually made a fresh drinking-ladle from the leaf of the *Nannorrhops*; but here I was informed by the officers of the 5th N. I., that in the hills to the north and east of Badish-khél, along all the streams and in springs, bowls made from the bark of the apricot usually lay floating in the pools for general use. This custom I found extended as far west as the Zérán valley; but there the bark from the knots of the walnut constituted the usual public drinking-cup. It is a curious custom, showing either that only persons of the same brotherhood or of one caste traverse these parts, or that the people are more liberal than elsewhere, and do not object to drink from a cup that has already been used by others. On the conglomerate cliffs overhanging the Karmána stream, where it is crossed by the main road, a variety of *Hypericum cernuum* was collected; it is a bush from 2 to nearly 4 feet in height, with bright yellow flowers never white, but only half the size of the type. *Myrtle* is common along the watercourses, and not, as previously found, in isolated clumps. In the damp corners of what looked like old fields, or at least demarcated plots of land, near the British fort of Shálizán, I collected *Ophioglossum vulgatum*, where it was growing in some abundance. The most common grasses found on the shingle plains were *Chloris villosa* in great flat patches, mapping the ground (if I may so term the peculiarity of its growth), a few flower-heads occurring on each patch at irregular intervals throughout the whole summer, *Panicum sanguinale*, *Andropogon punctatus*, *commutatus*, and *laniger*, and *Anthistiria anathera*. Along the edges of the dry watercourses, and on the higher island-like plots of ground in the beds of these dried-up streams, *Saccharum Griffithii*, a great coarse stiff grass, occurring in

large tussocks, is very striking, owing to the absence of other vegetation generally than to any peculiarity of its own. Along the banks of the Zérán and Malána streams, and on the sides of the watercourses up to 6000 feet altitude, but not further west, *Iris ensata* is common, growing in clumps as in Kashmír, but certainly not in the same luxuriant profusion. At the base of the low hills, at an elevation of 6000 feet, extending westward nearly to the Shend-toí and eastward beyond Zérán, I met with a shrub, about 2 feet in height, growing in isolated, densely-matted, cushion-like masses. When first seen, it was covered with heads of bright rose-coloured flowers, which were greedily browsed by goats and sheep. It belongs to the Rubiacea, and is the new genus *Aitchisonia* described by Mr. Hemsley. It is allied very closely to *Leptodermis*, and will probably have to be placed between that and the genus *Putoria*. Its leaves, when bruised, exhale an extremely fœtid odour, a peculiarity common to the above-named genera. One of the more interesting features in this plant (*Aitchisonia rosea*) is that it is dimorphic; and, as far as we yet know, the dimorphism extends only to the styles, which in some flowers are long, in others short, the stamens remaining the same as to length and position.

At the village of Zérán, cultivated in a sacred grove, I this year came across one large old tree and several smaller younger ones of *Pinus halepensis*. It seems to be cultivated throughout Afghánistán from Kándahár to Jellállabád. I must say that I was disappointed at this pine not turning out a new species, for the sake of my friend Dr. Cattell, F.L.S., who in this Kábul expedition, as Surgeon to the 10th Hussars, was the first to send specimens to Sir Joseph Hooker at Kew, recognizing it as a different pine to the ordinary Himalayan ones. Sir J. D. Hooker, deceived by Griffith having sent cones of this with leaves of *P. excelsa*, at first supposed it to be a new species. He himself, however, discovered the mistake, and referred Dr. Cattell's specimens rightly to *P. halepensis* before receiving mine.

Vegetation of the Valleys of the Zérán, Malána, and Darbán Streams.

On the ascent of the Zérán and Malána gorges, on the faces of

the precipitous cliffs, at an altitude of from 7000 to 8000 feet, a grass occurs which has extremely tough, elastic, hair-like leaves; and, owing to these properties, it is valued as bedding, being collected and brought as presents to the priests, who spread it on the floors of the rest-houses for the comfort of travellers. It is not found to the west of Malána. I regret that I could not get it in flower or fruit, and therefore am unable to say what it is; but from its general appearance I take it to be a species of *Stipa*. Besides being used as bedding, pieces of the turf bearing the long pendent leaves are hung up as tokens in the shrines, showing that the natives have also some religious superstition connected with the plant. East of Shálizán I saw no *Cratægus* or deodar; and in neither Malána nor Zérán gorges did I see any yew. It is noteworthy that large deodar forests exist on the northern face of the Saféd-koh range, notwithstanding the total absence of this tree in these valleys on the southern exposure. The indigenous walnut and *Quercus semecarpifolia* form the main feature of the forests in the Malána and Zérán valleys, from 7000 to 9000 feet, and occasionally as far up as 10,000 feet. That the walnut is wild here is proved both by the position it occupies in the forests and the formation of its fruit, which is quite different in shape from that of the cultivated tree, besides possessing an extremely thick shell with little or no kernel. It is also a significant fact that the natives designate the wild tree and fruit by a Púshtu term, whereas to the cultivated fruit and tree the usual Persian name is applied. The birch, *Betula Bhojpattra*, is much commoner here than it is further west, and forms thin forests on the northern exposures of the valleys in the interior ranges of these hills—not maintaining its position solely on the ridges, as it does further west in the Shend-toí gorge, a circumstance which gives it its native name in those parts. Although the birch descends as low as 9000 feet, I have never seen it associated with the walnut, as the former is limited to the colder exposures, whereas the walnut prefers the warm nooks and outer valleys. Extending as far west as the Shend-toí at 7000 feet, I this year collected *Corydalis ramosa*, a plant employed medicinally by the natives for the treatment of eye-diseases, simply, I believe, because it has a yellow watery juice, as every plant with a yellow juice seems to be by them considered a sovereign medicine, and all are called indiscriminately

Mamírán. In the birch-forests of the Malána valley, at an elevation of nearly 10,000 feet, *Aralia cachemirica*, an eastern form, was common, and with it *Trillium Govanianum*, *Actæa spicata*, and *Aspidium Filix-fœmina*—all of which were not collected last year. On the ascent to the Nangrár Pass, at 11,000 feet, I picked up a couple of specimens of *Campanula aristata*. On the pass itself, chiefly, however, on the southern exposure, the main ridge was covered with a dense turf made up mainly of *Kobresia schœnoides* and *K. scirpina*; and with them, but also extending to the west base of Mount Síka-rám, keeping to the same altitude, was *Papaver nudicaule*, with its brilliant orange-golden flowers, in great luxuriance. In the same turf, but in hollows where moisture collected, *Polygonum Bistorta* was found in abundance—the typical large-leaved form, as well as intermediate varieties down to a miniature state, though always with a thick distorted rootstock. It was not collected further west. In the Darbán valley, at 8500 feet, with a northern exposure, the vegetation was more of a West-Himalayan type, and corresponded to that met with at Murree at 7500 feet. The ivy was here first noticed supporting itself on the trunks of trees, this habit, no doubt, indicating the presence of more moisture. *Habenaria brachyphylla* was common in rich loam at the roots of some trees. *Rhododendron afghanicum* seems to be limited to the outer parts of the Shend-toí and Darbán valleys.

Vegetation of the Hariáb District.

The ridges of Mount Síka-rám above 8000 feet, where not covered with forest, present an extremely barren aspect, compared with similar heights in the Saféd-koh range, where grasses and green soft herbs and low shrubs form meadows, or what at a little distance look like them; whereas in the Hariáb district the soil is barren, and the herbs and shrubs that do exist are of a hard spinous nature, sparingly scattered over the stony soil. In addition to these spinous forms, *Umbelliferæ* are frequently met with; and thus the characteristic Afghan flora becomes more apparent. I here collected:—8 species of *Cousinia*, 4 of which are new; 4 species of *Acantholimon*, all probably new; 6 species of *Onobrychis*, 4 of which are new; 27 species of *Astragalus*, 10 of which are new; 3 species of *Scabiosa*, 1 of

which is new; *Atractylis cuneata*, a true Afghan type, only found previously by Griffith; *Lactuca*, 6 species; *Centaurea*, 4 species; *Cnicus*, 4 species; *Artemisia*, 7 species; a new *Tanacetum*; *Gypsophila Stewartii*; and the following *Umbelliferæ*—*Angelica Strattoniana*, a new species, three new species of *Pleurospermum*, and *Ferula communis*. *Onobrychis cornuta* and *O. spinosissima*, together with some species of *Astragalus*, *Acantholimon*, and *Gypsophila* give a distinctive feature of their own to the country, due to their forming thorny masses of various sizes, from that of a hedgehog to 4 feet in depth and 18 feet in circumference—extremely pleasant to look upon when covered with a mass of soft green leaves and bright blossoms.

Miscellaneous.

The fig, *Ficus Carica*, is cultivated in some of the gardens at Shálizán, producing fair fruit. I met with a form of the cultivated pea, *Pisum sativum*, this year, both in the Hariáb and Kuram districts, grown as a field-crop; it resembled the small pea cultivated in Ladák. The stems and leaves of *Angelica Strattoniana*, *Ferula communis*, *Pleurospermum*, n. sp., and *Codonopsis* are eaten raw, as well as cooked, as relish to their bread by the natives. The leaves of *Othonnopsis intermedia* are commonly used as a substitute for soap. A yellow dye is extracted from the roots of *Jasminum revolutum*. The stocks of guns and pistols are usually made of walnut-wood; bows, chiefly employed for shooting with pellets, from the wood of *Euonymus*. I have only seen a few arrows; and these were made from the reeds of *Arundo Donax*. The roots and leaves of *Codonopsis* are made into poultices, and employed in the treatment of bruises, ulcers, and wounds. The crushed rootstocks of *Euphorbia Thomsoniana* are employed by the natives for washing their heads, and, when boiled, used as a purgative and emetic.

The following enumeration includes not only the additional species collected in 1880, but also notes on and the names of many of those collected in 1879, the names of which were either not determined or incorrectly given in my former paper. The numbers belonging to the two collections are always distinguished, those of 1879 having that year within parentheses, and separated from those of 1880 by the sign =.

List of the Plants collected, with Notes and Descriptions of New Species, etc.

DICOTYLEDONES.

Polypetalæ.

Ranunculaceæ.

225, 340,=733 (1879). **Clematis Robertsiana,** *Aitchison & Hemsley in Journ. Linn. Soc.* xviii. p. 29. (Plate II. figs. 1–5.)

Adde: Achenia matura sericea, longe caudata, caudis longe plumosis.

415. **C. orientalis,** *Linn.*, var. **obtusifolia,** *Hook. fil. & Thoms.*

In the Darbán gorge, on rocks, at an altitude of 7000 feet.

159. **Thalictrum minus,** *Linn.*, var. **majus.**

In the Hariáb district, on embankments on the sides of fields where there is moisture, at an altitude of from 7000 to 8000 feet.

186, 237, 332,=463 (1879). **Anemone tetrasepala,** *Royle.*

Saféd-koh range, on the margins of forests, and in open grassy slopes on the inner hills, at an altitude of from 7000 to 10,000 feet. Not in the Hariáb district. In some localities it grows to fully 3 feet in height.

598 (1879). **Ranunculus** (§ **Euranunculus**) **afghanicus,** *Aitchison & Hemsley,* n. sp. Aff. *R. Aucheri,* foliis radicalibus reniformibus vel fere orbicularibus 2–5-fidis, lobis crenatis, foliis caulinis paucis 3-partitis, segmentis linearibus, acheniis valde compressis orbicularibus parcissime pilosulis breviter uncinato-rostratis.

Herba perennis, radicis fibris carnosis, cylindricis, fasciculatis. *Caules* erecti, 4–6 poll. alti, appresse pilosi, striati, sæpissime ramosi, 3–6-flori, ramis divaricatis. *Folia* radicalia longiuscule petiolata, glabra vel glabrescentia, crassiuscula, reniformia vel orbicularia, 1–1½ poll. diametro, 2–5-fida, lobis irregulariter crenatis; caulina 2–3, parva, sessilia, 3-partita, segmentis linearibus. *Flores* lutei, circiter 1 poll. diametro; sepala lata, obtusa, striata, pilosa, patentia, nec reflexa, margine hyalina colorata; petala 5, orbiculari-obovata, squama basilari orbiculari-obovata, magna; stamina numerosa. *Achenia* (matura non visa) numerosa, secus receptaculum elongatum cylindricum nudum inserta, parcissime pilosula, valde compressa, orbicularia, breviter uncinato-rostrata.—R. divergens, *Aitch. in Journ. Linn. Soc.* xviii. p. 30, *non Jord.*

In meadows, Karchátal, 10,500 feet. Not met with during the expedition of 1880.

93, 115. **Ranunculus Aucheri**, *Boiss. in Ann. Sc. Nat.* 1841, p. 351; *Fl. Or.* i. p. 34. Forma nana, 3–4-pollicaris.

Mount Síka-rám, June, on stony ground, at an altitude of from 11,000 to 13,000 feet. The plant varies in size from 3 to 9 inches. The sepals and petals persist; the latter increase in size, change in colour from a bright yellow to a livid brown, then crumpling up form a ball, the portions of which fall off on the fruit coming to maturity.

311. **R. aquatilis**, *Linn.*

Kuram district, in pools of water near the river, in water-courses, and flooded rice-fields, at an elevation of 5000 feet.

354. **R. Cymbalaria**, *Pursh.*

Péwár-marg; very local, on grassy slopes near springs of water, at 8000 feet.

123. **R. demissus**, *DC.*

On Mount Síka-rám, June, at an altitude of 13,500 feet.

116, =955 (1879). **Oxygraphis Shaftoana** *, *Aitch. & Hemsley*, n. sp. (Plate III. figs. 1–5.) Foliis 3-partitis, scapo sæpissime 1-bracteato, petalis 5–8 latis.

Herba perennis, scaposa, glaberrima, 3–4 poll. alta, radicis fibris carnosis, 1–3 poll. longis. *Scapus* solitarius, 1-florus, 1-bracteatus, bractea integra vel trifida. *Folia* (primum subtus purpurea) longe petiolata, crassa, subcarnosa, 3-partita, segmentis obovatis vel fere orbicularibus, usque ad 6 lineas latis, integris vel irregulariter dentatis. *Flores* lutei, circiter 1 poll. diametro; sepala persistentia, inæqualia, oblongo-orbicularia, obtusa vel rotundata; petala 5–8, late obovata, striata, persistentia. *Achenia* immersa, lævia, breviter rostrata.

Mount Síka-rám; on shingly débris, at an elevation of from 11,000 to 14,000 feet, very profuse. The petals are at first of a bright Ranunculus-yellow; these, with the sepals, increase in size, change colour to a yellow-green, then brownish, and lastly to a purple hue, wither, form into a ball round the fruit, and fall off with the fruit as it ripens.

802 (1879). **Isopyrum uniflorum**, *Aitchison & Hemsley*, n. sp. Aff. *I. cæspitosi*, sed foliorum segmentis obovatis trifidis, floribus vix 6 lineas diametro, petalis suborbicularibus, stylis fere rectis, ovariis epapillosis.

Herba cæspitosa, glaberrima, caudice petiolis vetustis dense vestito. *Scapus*

* Named after Capt. E. D. Shafto, R.A., who was killed at Kabul on the 16th October, 1879, by the explosion of part of the Kabul magazine.

1-florus, 2-bracteatus, folia vix superantes. *Folia* graciliter petiolata, 2-ternata, segmentis parvis, obovatis, sæpissime 3-fidis. *Flores* cæruleo-flavi, vix 6 lineas diametro; sepala ovato-orbicularia; petala concava, suborbicularia; ovaria glabra, stylis fere rectis. *Carpella* circiter 7, matura ignota.

In the Shend-toí valley, on the marble rocks, in July, at an elevation of 10,000 feet.

326. **Aquilegia** sp.

Shend-toí gorge, in the forest, at 8000 feet.

219, 362,=732 (1879). **A. pubiflora,** *Wall.*, var.? **humilior,** *Aitch. & Hemsley.* Floribus majoribus, calcaribus longioribus fere rectis.

Along the Saféd-koh range westwards to the base of Mount Síka-rám, in crevices of rocks, at an altitude of from 10,000 to 12,000 feet.; flowers in June and July.

A very dwarf variety with extremely large handsome flowers.

263. **Actæa spicata,** *Linn.*

In the Malána valley, and on the inner hills of the Saféd-koh range, in birch forests, at an elevation of 9000 to 10,000 feet.

Menispermaceæ.

513. **Cocculus Leæba,** *DC.*

From Thal to Kuram, in the arid hills on the face of conglomerate cliffs, at an elevation of 4000 feet. Common.

Berberideæ.

185. **Berberis vulgaris,** *Linn.*

Shend-toí gorge, in the woods at 9000 feet.

The rest of my specimens of *Berberis* are varieties of *Berberis vulgaris*, L., and may be separated under three heads:—

a. Including the following numbers of distribution, 141, 224, =499 (1879), distinguishable from the others by the flowers being in racemes, and in having an oval long fruit, with a sessile stigma.

b. Numbers 49,=176, 176_2, 176_3, 176_5 (1879), including the specimens named *B. orthobotrys*, Bienert, ex herb. Bunge, last year; in which the flowers are subcorymbose, the fruit oval, and the stigma sessile.

c. Including the numbers 171, 176_1, 176_4, 252, 273, and =490 (1879). This includes the specimens that I named last year

B. calliobotrys, Bienert, ex herb. Bunge (of which I have not seen the fruit). The fruit of my specimens is spheroidal, and has the stigma supported on a distinct style.

Papaveraceæ.

139, 280, 357. **Papaver nudicaule,** *Linn.*

From the Nangrár pass westwards along the Saféd-koh range to Mount Síká-ram, in the meadows on the ridges of the northern slopes, at an altitude of from 10,000 to 11,500 feet. Extremely abundant.

114,=95, 121 (1879). **Corydalis Griffithii,** *Boiss.*; C. rutæfolia, *Hook. fil. & Thoms., non Sibth.*

In the Hariáb district and on Mount Síka-rám, at an elevation of from 7000 to 12,500 feet.

At the lower elevation growing near the roots of trees and bushes, where it flowers long before the bushes have any leaves; flowers salmon-colour tipped with dark purple.

201, 289,=789 (1879). **C. pulchella,** *Aitchison & Hemsley,* n. sp. (Plate IV. figs. 1–3.) Foliis iis *C. meifoliæ* simillimis sed glaucis, racemis laxioribus, bracteis amplis 3-pinnatisectis, calcari quam petala paullo longiore, petalo postico aptero, pedicellis fructiferis insigniter recurvis.

Herba perennis, glaberrima, radice elongato-claviformi. *Caules* erecti, usque ad 10 poll. alti, basi tantum ramosi. *Folia* glauca, longiuscule petiolata, ovato-oblonga, 3-pinnatisecta, usque ad 6 poll. longa, segmentis ultimis brevibus angustissimis. *Flores* lutei, angusti, 6–8 lineas longi, laxiuscule racemosi; racemi 10–20-flori, bracteati; bracteæ elegantes, 6–12 lineas longæ, 2-pinnatisectæ, segmentis filiformibus; sepala minuta, dentata; petalum posticum galeatum, dorso apterum, calcari curvo paullo brevius. *Capsula* oblonga, pedicellis arcte recurvis sæpius longior; semina 2-seriata, atra, nitida.—C. meifolia, *Aitch. in Journ. Linn. Soc.* xviii. p. 32, *non Wall.*

Along the Saféd-koh range, in the shingle between the boulders on the sides of alpine stream-beds, at an altitude of from 9000 to 11,000 feet.

The root of what seems to be one plant is made up of several pliant fibrous bundles all twisted round each other like the several strands of a rope. This was also brought to my notice, by the natives, in a species I collected near Dalhousie in the Western Himalaya at 8000 feet.

298, 324. **Corydalis ramosa,** *Wall.*, var.

Kuram district, between boulders in the dry beds of streams, at 7500 to 8000 feet; not in the Hariáb.

CRUCIFERÆ.

74, 385. **Arabis taraxacifolia,** *T. Anders.*

From the Péwár to the base of Mount Síka-rám, at an altitude of from 8000 to 9000 feet; July.

120 (1879). **A. alpina,** *Linn.* ?

Ali-khél, 7000 feet.

Draba alpina, *Linn.*

After a careful examination of the large amount of material at my disposal, I have come to the conclusion that the whole of it may be regarded as *D. alpina*, Linn., under two forms:—

a. A rough, harsh plant, with thick, coarse leaves and large, but few, flowers in each corymb. This would include numbers 99, 126,=825, 1, 2, 3, 4, 6 (1879).

b. A slender, soft plant, with small, numerous flowers in a lax corymb. This includes numbers 112, 120, 122, 124, 126 *a, b,* and 464, 5 (1879).

Under *a* may be included the specimens of Griffith's plants, No. 1368, Cat. Distrib., collected at Koh-i-baba at from 14,000 to 15,000 feet, and named *D. Armena*, Boiss.

206 (1879). **Conringia,** sp. Is *Conringia orientalis*, Andrz.

475 (1879). **Erysimum,** sp. Is *Erysimum asperulum*, Boiss. ?

532 (1879). **Pachypterygium,** sp. Is *Pachypterygium brevipes*, Bunge.

119=597 (1879). **Chorispora,** sp. Is *Chorispora Bungeana*, Fisch. & Mey.

Hariáb district, on the exposed ridges of hills, at an elevation of from 11,500 to over 12,000 feet.

The natives collect and eat the pods, which in flavour much resemble those of *Raphanus sativus*, L., var. *caudatus*.

The typical plant is from Altai, and differs from the Afghan specimens in the pods being much less constricted between the seeds.

CAPPARIDEÆ.

517. **Polanisia viscosa,** *DC.*

Between Mandúri and Chaprí, August.

320. **Capparis spinosa,** *Linn.*

Common from Thal to Kuram, on conglomerate rocks, from 2500 to 4000 feet.

Violarieæ.

86, 391,=500, 119 (1879). **Viola Patrinii,** *DC.*, vars.

Hariáb, in pine forests, at an altitude of from 8000 to 9000 feet.

Caryophylleæ.

1, 27, 173, 547,=638 (1879). **Dianthus crinitus,** *Smith,* vars.

From Thal to the Kuram district, on stony ground; but most profuse on the shingle plains of Kuram. Flowers white, sometimes roseate.

167, 351, 396,=938, 856 (1879). **D. fimbriatus,** *Bieb.*

Hariáb district, profuse on stony ground at an altitude of from 8000 to 9000 feet. Flowers white to an orange-red.

7, 31, 59, 352,=225, 225 *a*, 255 (1879). **Gypsophila Stewartii,** *T. Thoms.*

From the plains of Kuram westward to the Hariáb district, Mount Síka-rám, and Serátígah, from 4000 to over 10,000 feet in altitude.

The plant varies greatly in appearance, according to the altitude at which it grows: on the Kuram plains it grows very close and compact in dense clusters, which early in the season, when they are bright green, look like clumps of moss; at the higher altitudes it forms loose cushions from 6 to 8 inches in depth, and quite loses its moss-like appearance.

473 (1879). **Silene,** n. sp.?

From the village of Péwár to Ali-khél, at an altitude of 6000 to 7500 feet; June.

182, 212, 412,=443 (1879). **Lychnis** (§ **Melandrium**) **cabulica,** *Boiss.*

The specimen noted as *L.* sp., near *macrorhiza*, Royle, is probably merely a stunted form of this.

288. **Cerastium Thomsoni,** *Hook. fil.*

On the Zérán pass from 11,000 to 12,000 feet, profuse; flowers large, white.

Stellaria glauca, *Linn.*

Collected by Major Collett (no. 96) on the Saféd-koh.

555 (1879). **Stellaria Kotschyana,** *Fisch.*

Hariáb district, not uncommon in pine forests, at 7000 feet; June to August.

Arenaria Griffithii, *Boiss.*

I have no doubt now that my specimens of 1879 are this plant.

Elatineæ.

497. **Bergia æstivosa,** *Wight & Arn.*

Between Alizai and Mandúrí, on saline clay soil, forming a dense low scrub.

Hypericineæ.

315,=65 (1879). **Hypericum cernuum,** *Roxb.*, var.

Flowers bright yellow, and half the size of the type.

613 (1879). **H. perforatum,** *Linn.*

Malvaceæ.

426. **Abutilon Avicennæ,** *Gaert.*

Kuram, August.

604. **A. bidentatum,** *Hochst.*

Between Thal and Kuram, August.

541. **Hibiscus Solandra,** *L'Hér.*

At the north-west base of Mount Tór-ghar near Thal, above 2000 feet.

474. **H. Trionum,** *Linn.*, var.

Between Shinak and Badish-khél, in rice-fields.

Has quite a different habit from the type, being an erect plant.

462. **Gossypium herbaceum,** *Linn.*

Cultivated from Thal to a little west of Kuram, but not above 4000 feet.

Tiliaceæ.

514. **Grewia populifolia,** *Vahl.*

From Thal to near Badish-khél, not above 3000 feet; flowers white.

512. **G. salvifolia,** *Heyne.*

From Mandúrí to Chaprí, not above 3000 feet. Forms a rather large, woody bush over 12 feet in height; flowers orange-yellow.

520. **Grewia villosa,** *Willd.*

At the south-west base of Mount Tór-ghar, near Thal.

A very gregarious shrub, recognized at once by its large, villous, crustaceous fruit.

424, 476. **Corchorus olitorius,** *Linn.*

Occasional, from Thal to Kuram.

527. **C. trilocularis,** *Linn.*

Occasional from Thal to Kuram.

ZYGOPHYLLEÆ.

428. **Tribulus terrestris,** *Linn.*

From Thal to Shálizán, on dry stony ground, common.

GERANIACEÆ.

217, 346,=600, 836, 878 (1879). **Geranium collinum,** *Bieb.*

Saféd-koh range and Hariáb district, amongst turf in swampy ground near springs, at an altitude of from 8000 to 10,000 feet. Flowers rose to rose-purple, sometimes white; roots carrot-colour, employed medicinally.

299,=1005 (1879). **Impatiens amphorata,** *Edgew.*

In the interior of the Safêd-koh range, at an altitude of 8000 to 10,000 feet. Flowers rose-colour, with the spur light yellow; stems glass-like, semitransparent; common; July and August.

45, 172, 347,=653 (1879). **I. brachycentra,** *Kar. & Kir.*

In the Kuram and Hariáb districts, in dry beds of streams, at an altitude of from 6000 to 8000 feet. Flowers very minute, white, produced during the heat of summer.

297,=587 (1879). **I. Lehmanni,** *Hook. fil. & Thoms.* Capsula linearis, gracilis, fere pollicaris, oligosperma.

Kuram district, on the stony margins of streams, at an elevation of from 6000 to 8000 feet, ascends to the lower limit of *I. amphorata*, Edgew., but never mixes with it. Flowers purple; stems opaque. A very common plant.

RHAMNEÆ.

507. **Zizyphus Nummularia,** *Wight & Arn.*

From Thal to Kuram, up to 4000 feet.

It is usually met with as a spreading woody shrub, but occasionally forms a small tree. At Kuram it is found associated with *Z. vulgaris*, Lamk.

491. **Zizyphus oxyphylla,** *Edgew.*

Common along the banks of the Kuram river and its tributaries as far as Shinak, up to an altitude of 3000 feet.

It occurs as a large shrub, and in many cases it is almost arboreous.

106, 107,=915 (1879). **Rhamnus persica,** *Boiss.* Forma alpina, nana, disco glabro.

Saféd-koh range, at an altitude of 13,000 feet.

This seems to be an alpine form of *R. persica*, extending eastward to Garwhal.

319. **Sageretia Brandrethiana,** *Aitch.*

From Thal to Kuram, up to an altitude of 4000 feet.

759 (1879) is an extremely glabrous form of the same species.

SAPINDACEÆ.

853 (1879). **Acer,** sp.

Seems to be a variety of *A. monspessulanum*, Linn.

605. **Dodonæa viscosa,** *Linn.*

From Thal to the hills south of the Kuram river opposite Kuram, up to an altitude of 5000 feet.

400, 396 (1879). **Staphylea Emodi,** *Wall.*

The bark on the young stems is marked with splashes of white on a dark olive-green ground, resembling the markings on the skin of a snake; hence sticks of this shrub are carried by the natives as a protection against snakes. The same protective power is ascribed to them along the whole frontier, through Hazára to Kashmír, where they are similarly employed. As walking-sticks they are useless, owing to their being hollow and the wood very brittle.

ANACARDIACEÆ.

607,=233, 342 (1879). **Rhus Cotinus,** *Linn.*

38 (1879). **Pistacia integerrima,** *J. L. Stewart* ?

606,=234 (1879). **P. mutica,** *Fisch. & Mey.*

The nuts are roasted and eaten.

17, 361 (1879). **P. mutica,** *Fisch. & Mey.*, var. **cabulica,** *Eng.*

=nos. 1268, 1269 Griffith, 1072 Stocks, 126 Bellew, in herb. Kew.

528 (1879). **P.** sp.

Is near *P. Lentiscus*, Linn.

LEGUMINOSÆ*.

545. **Argyrolobium roseum,** *Jaub. & Spach.*

From Tór-ghar to Chaprí, common; closely appressed to the ground.

310. **Lotus tenuifolius,** *Reich.*

On the banks of the Kuram river, amongst pasturage, at an altitude of 4000 feet.

539. **Cyamopsis psoraloides,** *DC.*

Common between Tór-ghar and Chaprí.

522. **Tephrosia pauciflora,** *Graham.*

At Thal, growing amongst shingle; September.

453, 460. **Sesbania aculeata,** *Pers.*

Common from Thal to Kuram, in rice-fields, August.

238, 710 (1879). **Astragalus** (§ **Hypoglottis**) **kuramensis,** *Baker, in Journ. Linn. Soc.* xviii. p. 46. (Plate V. figs. 1-5.)

101, 373. **Astragalus** (§ **Acanthophace**) **Ajfreidii,** *Aitch. & Baker,* n. sp. Suffruticosus, nanus, ramosissimus, pulvinatus, foliis densissimis pilis albidis hispidis adpressis tenuiter vestitis, stipulis minutis deltoideis, rhachibus pungentibus vetustis persistentibus, foliolis 2–3-jugis strictis linearibus complicatis apice induratis, floribus paucis ad axillas foliorum subsessilibus solitariis, calycis dentibus lanceolatis, quam tubus oblongus parce pilosus 3–4plo brevioribus, vexillo aurantiaco glabro quam calyx duplo longiore, legumine oblongo sessili uniloculari obscure piloso 3–4-spermo.

Suffrutex pulvinatus, radice elongata fusiformi lignosa, caulibus densissime aggregatis dichotome ramosis, 2–3 poll. longis, deorsum rhachibus duris ascendentibus foliorum delapsorum præditis. *Folia* novella densissima, ascendentia, 9–12 lin. longa, stipulis minutis deltoideis basi solum connatis, foliolis erecto-patentibus strictis, 2–3 lin. longis, facie canaliculatis. *Calyx* pallide viridis, 4 lin. longus, pilis adpressis albidis tenuiter vestitus, dentibus lanceolatis basi deltoideis 1–1½ lin. longis. *Corolla* aurantiaca, vexillo oblongo unguiculato, 8 lin. longo, 2 lin. lato, alis oblanceolatis, quam vexillum distincte brevioribus, carina 6 lin. longa, alis breviore. *Legumen* sessile, oblongum, uniloculare, 4–5 lin. longum, seminibus 3–4 griseo-brunneis transversaliter oblongis.

Remarkable for its dwarf, densely tufted habit, very crowded leaves with pungent points both to the rhachises and leaflets, and few flowers not protruding out of the dense masses of stems and foliage.

On the spurs of Mount Síka-rám and the Larkarai pass, at an altitude of from 10,000 to 12,000 feet. Flowers greenish yellow.

* For the identification of the Leguminosæ and the description of the new species, I am indebted to Mr. J. G. Baker, F.R.S.

This plant very much resembles the furze (*Ulex*) in miniature; it is not very common, or it is easily overlooked, as I did not collect it during 1879.

25, =167 (1879). **Astragalus** (§**Calycophysa**) **congestus**, *Baker*, n. sp. Fruticulosus, nanus, ramosissimus, foliis densissimis dense pilosis, rhachibus pungentibus vetustis persistentibus, stipulis magnis petiolo adnatis apicibus liberis deltoideo-cuspidatis, foliolis parvis lanceolatis, 4–6-jugis, erecto-patentibus, racemis copiosis congestis sessilibus axillaribus, bracteis scariosis deltoideis persistentibus quam calyx duplo brevioribus, calycis pilosi dentibus linearibus, quam tubus triplo brevioribus, petalis rubro-purpureis breviter exsertis, legumine parvo oblongo uniloculari dispermo.

Suffrutex ramosissimus, pulvinatus, caulibus dense aggregatis 3–4 poll. longis deorsum rhachibus pungentibus foliorum vetustorum ascendentibus armatis. *Folia* novella 9–12 lin. longa, stipulis 3–4 lin. longis dimidio inferiore petiolo adnatis, rhachibus pungentibus, foliolis crebris erecto-patentibus firmulis, 1½–3 lin. longis, utrinque dense breviter pilosis. *Racemi* copiosi, congesti, sessiles, 4–8-flori, bracteis scariosis persistentibus 1½–2 lin. longis. *Calyx* floriferus 3–4 lin. longus, tubo magno oblique oblongo pallido breviter piloso post anthesin persistente valde accreto, dentibus parvis plumosis basi dilatatis. *Corolla* 4½–5 lin. longa, rubro-purpurea, petalis subæquilongis, vexillo glabro obovato-unguiculato 2 lin. lato. *Legumen* sessile, oblongum, 2 lin. longum, in calycis tubo accrescente scarioso 3 lin. diam. inclusum.

A near ally of *A. susianus*, Boiss., with which it quite agrees in general habit and inflorescence, differing in its laxer vestiture, lanceolate leaflets, shorter calyx-teeth, smaller bracts, &c.

It was distributed, 167 (1879), as *A. susianus*, Boiss., var.

76, 174 (1879). **A. decemjugus**, *Bunge*.

Near Kuram; it was collected for fodder.

61, 80, =1215 (1879). **A.** (§ **Acanthophace**) **Hemsleyi**, *Aitch. & Baker*, n. sp. Suffruticosus, foliorum rhachibus duris pungentibus albo-tomentosis vetustis persistentibus, stipulis minimis petiolo adnatis, foliolis 6–8-jugis minutis obovatis petiolulatis junioribus parce hispidulis adultis calvatis, racemis axillaribus subsessilibus 2–4-floris, bracteis minutis lanceolatis, calycis dentibus linearibus quam tubus oblongus tenuiter albo-hispidulus sesqui vel duplo brevioribus, petalis purpurascentibus quam calyx sesqui longioribus, legumine oblongo glabro uniloculari 3–4-spermo.

Suffrutex nanus, ramosissimus, caulibus lignosis rhachibus foliorum densissimorum pungentibus ascendentibus armatis. *Folia* novella 12–18 lin. longa, rhachi pungente albo-tomentoso; stipulæ 1 lin. longæ, apicibus perparvis patulis deltoideis; foliola crassa, pallide viridia, 1–2 lin. longa, pilis hispidulis albidis præsertim ad marginem prædita. *Racemi*

axillares, pedunculis et pedicellis brevibus albo-pilosis. *Calyx* floriferus 2½–3 lin. longus, tubo oblongo parce albo-hispidulo. *Vexillum* glabrum, oblongo-unguiculatum, 4½–5 lin. longum; alæ vexillo paulo breviores; carina alis vix brevior. *Legumen* sessile, oblongum, subglabrum, 4 lin. longum.

A near ally of *A. horridus*, Boiss., from which it differs by its much smaller stipules, leaflets with much shorter and fewer hairs, calyx without any black hairs, shorter, less exserted corolla, &c.

In the Hariáb district, common at 7500 feet, occurring in large, flat, circular patches. Flowers greenish, tipped with rose-pink.

283. **Oxytropis glacialis**, *Benth.*

On meadows at the Nangrár pass, at an altitude of 11,000 feet.

68, 86, 186 (1879). **Onobrychis** (§ **Hymenobrychis**) **dasycephala**, *Baker in Journ. Linn. Soc.* xviii. p. 48. (Plate VI. figs. 1, 2.)

75,=512, 484 (1879). **O.** (§ **Hymenobrychis**) **laxiflora**, *Baker*, n. sp. Herbacea, perennis, pilis brevissimis albidis adpressis ubique prædita, foliolis 9–17 ellipticis crassiusculis pallide viridibus, racemis laxis elongatis, bracteis minutis scariosis lanceolatis, calycis dentibus tubo æquilongis, corollæ alis oblanceolatis lilacinis, petalis reliquis pallide luteis pulchre purpureo-venosis distincte brevioribus, legumine plano tenui semiorbiculari late cristato breviter piloso, areolis disci parce spinosis, margine dentibus pluribus parvis deltoideo-cuspidatis armato.

Herba perennis, caulescens, ad collum radicis copiose ramosa, caulibus erectis pedalibus et ultra firmis teretibus parce ramosis pilis adpressis albidis subtilibus inconspicuis vestitis. *Folia* imparipinnata, 2–4 poll. longa, stipulis parvis deltoideis acuminatis persistentibus, petiolo ½–1½, pollicari, foliolis oppositis vel suboppositis breviter petiolulatis planis 4–6 lin. longis. *Racemi* centrales demum semipedales et ultra, pedicellis brevissimis pilosis, bracteis minutis lanceolatis scariosis brunneis persistentibus. *Calyx* brunneus, obscure pilosus, 1½ lin. longus, dentibus lanceolatis vel deltoideis, tubo campanulato subæquilongis. *Corolla* glabra, semipollicaris et ultra, vexillo obovato 4–5 lin. lato pallide luteo, venis flabellatis gracilibus purpureis decorato, alis saturate lilacinis concoloribus, petalis reliquis distincte brevioribus, carina truncata 3 lin. lata. *Legumen* circinatum, planum, semiorbiculare, monospermum, disci areolis subhexagonis muris elevatis parce spinosis, cristæ areolis duplo longioribus quam latis muris tenuibus integris, margine corneo brunneo dentibus parvis concoloribus crebris armato.

This is the plant which Dr. Aitchison gathered last year, and which closely resembles *O. heterophylla*, C. A. Meyer, in habit, leaves, and flower. This year he has obtained the pod, which is

that of a different section. Its position in Boissier's sequence of species will be next to *Onobrychis radiata*, Bieb.

Hariáb district, on the artificially raised hillocks around the margins of fields, at an altitude of 7500 feet; very common.

591 (1879). **Vicia hyrcanica,** *Fisch. & Mey.*

Near Karchátal in the Hariáb district; a weed on cultivated land.

It has large yellow solitary flowers, usually not sessile, and a flattish broad pod like that of *Pisum sativum.* Distributed along with and named *V. sativa*, Linn., under no. 591 (1879).

87. **Pisum sativum,** *Linn.*

Cultivated as a field-crop in the Kuram and Hariáb districts.

473. **Phaseolus Mungo,** *Linn.*

Extensively cultivated as a field-crop from Thal to Kuram, and generally so in the Kuram district.

538. **Rhynchosia aurea,** *DC.*

From Thal to Chaprí, in hot, dry, stony localities; September.

516. **R. minima,** *DC.*

From Thal to Mandúrí, under 3000 feet. It spreads densely over the surface of the bushes to which it clings, so much so as to completely hide its support.

517. **Dalbergia Sissoo,** *Roxb.*

From Thal to Badish-khél; occurs as an indigenous timber-tree along the banks of the Kuram river and its tributaries, up to nearly 3000 feet.

I have seen it cultivated, but more frequently as a protected self-sown tree at shrines &c.

Rosaceæ.

Spiræa brahuica, *Boiss.*

50, 67. Large-flowered.

144, 248. Small-flowered.

Some of my specimens were taken from much more vigorous plants than those upon which the species was founded. Growing in a more humid climate and under shade, the plant is spineless, and the leaves and flowers are much larger than in the type, the latter being in some cases at least half an inch in diameter. My specimens from the open, dry, stony country possess the small flowers and leaves, with the extremely contorted, spinous branches of the type.

In my distribution of 1879 the two forms were mixed.

245, 295,=804, 422 (1879). **Rubus niveus,** *Wall.*, var. **Aitchisonii,** *Hook. fil.*

Common in the Kuram district at an altitude of from 6000 to 9000 feet. Fruit orange-red, becoming purplish; good to eat.

200,=765 (1879). **R. purpureus,** *Bunge.*

Kuram and Hariáb districts, growing amongst large boulders and low shrubs, at the upper limit of trees.

Is a fine rasp-like scrub, having a large orange-red fruit the size of a good bramble, which is fleshy and good to eat.

The remarks under *R. niveus* and *R. purpureus* in my previous paper were transposed, and should stand as above.

41, 158, 178, 274=309 (1879). **Rosa Beggeriana,** *Schrenk*, var. *a.* **genuina,** *Crépin* *. (Plate VII. figs. 1–3.)

This was distributed under 309 (1879) as *R. anserinæfolia*, Crépin, *non Boiss.*

A common shrub at the western extremity of the Kuram district and throughout the Hariáb, in the vicinity of streams and watercourses; it is also very common near cultivation, where it forms natural hedges along the various channels of irrigation, at an altitude of from 4000 to 9000 feet.

It forms a bush of from 4 to 6 feet in height, the latter in more favoured localities. When in bloom, it is covered with a mass of pure white small flowers. The fruit is little larger than an ordinary pea, at first orange-red, when fully ripe of a deep purple-black. The calyx drops off as soon as the fruit reaches maturity; and the ripe achenes are seen dropping out of the aperture at the extremity of the fruit. The shrub is briar-scented.

This species is employed, as well as *R. Eglanteria* and *R. Ecæ*, the gooseberry, and *Hippophaë*, in forming hedges in the Hariáb district; and is much browsed by cattle, especially goats.

165 (1879). **Rosa Ecæ,** *Aitch.* (Plate VIII. figs. 1–3.)

Erratum.—At line 11, page 55, vol. xviii. Linn. Soc. Journal, *for* "achenia villosissima" *read* "styli villosissimi; achenia primum villosa, pilis demum deciduis."

178 A, 336. **R. Webbiana,** *Wall.*, var. *a.* **genuina,** *Crépin.*

Common.

56. **R. Webbiana,** *Wall.*, var. *γ.* **microphylla,** *Crépin.*

Common.

* M. Fr. Crépin, Director of the Brussels Botanic Garden, who has made a special study of Asiatic roses, has obligingly communicated his determinations of my Afghan species.

138. **Pyrus Aucuparia,** *Gært.*, var.

On the north-west slopes of Mount Síka-rám, at an altitude of 11,500 feet.

Has much larger flowers than the type. No fruit collected.

277. **Cotoneaster tomentosa,** *Lindl.*

In the Kuram district, from 7000 to 8000 feet; in fruit, July.

Occurs as a small tree; and my specimens would unite the two species *C. tomentosa*, Lindl., and *C. bacillaris*, Wall.

SAXIFRAGEÆ.

133. **Saxifraga Stracheyi,** *Hook. fil. & Thoms.*

Mount Síka-rám, on overhanging rocks, at an altitude of 11,000 feet.

383 (1879). **S. (§Kabschia) afghanica,** *Aitchison & Hemsley in Journ. Linn. Soc.* xviii. p. 56. (Plate IX. figs. 6–12.)

CRASSULACEÆ.

538 (1879). **Cotyledon (§Umbilicus) tenuicaulis,** *Aitchison & Hemsley in Journ. Linn. Soc.* xviii. p. 57. (Plate X. figs. 1–5.)

456, 937 (1879). **Sedum adenotrichum,** *Wall.*

My specimens differ from the type in having glandular hairy leaves.

851 (1879). **S. heterodontum,** *Hook. fil. & Thoms.*

My plant is this, and not *S. asiaticum*, Decne., for which it was distributed last year.

469 (1879). **S. pachyclados,** *Aitchison & Hemsley in Journ. Linn. Soc.* xviii. p. 58. (Plate X. figs. 6–10.)

LYTHRARIEÆ.

468. **Ammannia baccifera,** *Linn.*

Common between Badish-khél and Walli Mahomed-kalla, in rice-fields.

417. **A. pentandra,** *Roxb.*

Shálizán, in rice-fields, profuse.

430. **Lythrum Salicaria,** *Linn.*

Kuram district, in wet localities, such as rice-fields, ditches, and watercourses, at an altitude of from 3000 to 5000 feet.

It extends westwards from Kulu (*Edgew.*), Kashmir (*T. Thoms.*), Hazara (*Falc.*), to Afghanistan (*Griffith*), North Africa, Europe, North America, and is also found in Siberia.

Punica granatum, *Linn.*

Kuram district, from 3000 to 5000 feet. The pomegranate is indigenous, and it is also cultivated for its fruit.

Onagrarieæ.

Epilobium minutiflorum, *Haussk. MSS. in herb. Kew.*

My plants nos. 348 and 651 (1879) (named *E. tetragonum*, Linn.), and my plant, without a number, collected at Shálizán, June 1879, all correspond exactly to the specimens of *E. palustre*, Linn., in Kew herbarium that have been named *E. minutiflorum* by Haussknecht.

The flowers in my specimens change in colour from white to rose.

939 (1879). **E. roseum,** *Schreb.* ?

Regarded as *E. roseum*, Schreb., var. *anagallidifolium* (Lamk. sp.) by C. B. Clarke, Fl. Brit. India; but in Kew herbarium it has been named *E. pseudo-obscurum*, Haussk., MSS.

651 A (1879). **E. tetragonum,** *Linn.*

Is not that plant, but corresponds to no. 29714 herb. C. B. Clarke, named *E. palustre*, Linn., which is designated a new species, Haussk. MSS. in Kew herbarium ; and with it I identify my plant no. 300 of 1880.

Cucurbitaceæ.

498. **Zehneria umbellata,** *Thwaites.*

Thal to Badish-khél, from 2000 to nearly 4000 feet.

Characteristic of *Nannorrhops* scrub.

Ficoideæ.

528. **Orygia decumbens,** *Forsk.*

Near Thal, north-west base of Mount Tór-ghar, a little above 2000 feet, profuse.

Umbelliferæ.

929 (1879). **Bupleurum,** sp. Aff. *B. baldensis*, *β. olympici*, Boiss., differt caulibus numerosis recumbentibus, floribus luteis.

This may prove the type of a distinct species.

152. **Carum meifolium,** *Bieb.*, var. **divergens,** *Boiss. et Huet.*

Last year I named 478 (1879) *C. bulbocastanum*, Koch, var., which it is not, but is this plant.

313. **Sium angustifolium,** *Linn.*

Kuram district, in rice-fields and ditches, at 4000 feet, common.

846 (1879). **Pimpinella tripartita,** *Aitchison & Hemsley,* n. sp. (Plate XI. figs. 1–4.) Humilis, glaberrima, glauca, foliis parvis crassis, radicalibus longe petiolatis tripartitis (infimis fere vere trifoliolatis), segmentis sæpissime trifidis, umbellis sæpius triradiatis, fructu immaturo glabro.

Herba perennis, humilis (specimina nostra 6–9 poll. alta), prorsus glaberrima, glauca, radice crassiuscula valde elongata, caulibus gracilibus, divaricatis pauciumbellatis. *Folia* crassa, circumscriptione orbicularia, tripartita (infima subtrifoliolata, foliolis petiolulatis); segmenta sæpissime trifida, lobis rotundatis vel obtusis; caulina superiora pedata, lobis linearibus; inferiorum lamina ad 1 poll. diametro, petiolis usque ad tripollicaribus. *Umbellæ* compositæ, plerumque 3-radiatæ; radii 4–9 lineas longi, graciles; bracteæ nullæ; umbellulæ pauciforæ, ebracteolatæ, floribus minutis. *Fructus* immaturus glaber.

Dré-kalla, amongst the broken débris of stone, at 9000 feet, very rare; July.

294. **Chærophyllum villosum,** *Wall.*

No. 772 (1879) is not *C. reflexum,* Lindl., but is this species.

Kuram district, amongst grass, at from 9000 to 11,000 feet.

743, 744 (1879). **Pleurospermum** (§ **Hymenolæna**) **pulchrum,** *Aitchison & Hemsley in Journ. Linn. Soc.* xviii. p. 63. (Plate XII. figs. 1–7.)

398. **Pleurospermum,** n. sp.?

Material insufficient for description.

Mount Síka-rám, under the shelter of enormous rocks, at an altitude of from 10,000 to 11,000 feet, growing in rich loamy soil permeated by spring-water.

Occurs in extensive beds; and is much sought after and eaten by the natives in its fresh green state.

136, 394, =821 (1879). **Angelica Strattoniana*,** *Aitchison & Hemsley,* n. sp. (Plate XIII. figs. 1–7.) Glaberrima, radice maxima, caulibus pluribus ad bipedalibus, foliis crassis subcarnosis bi- v. triternatis, segmentis vel foliolis petiolulatis orbiculari-cordatis denticulatis.

Herba perennis, graveolens, omnino glaberrima, radice usque ad 3–4 ped. longa (interdum forsan ultra) et 2 poll. crassa. *Caules* plures, cavi, subaphylli, 1–2 ped. alti, sæpe 3-umbellati, umbellis lateralibus minoribus, sæpe sterilibus. *Folia* breviter petiolata, circumscriptione triangularia, bi- v. triternata, 6–12 poll. longa lataque, in vivis glauco-viridia; segmenta vel foliola petiolulata, crassa, subcarnosa (in siccis coriacea), orbiculari-cordata, nonnulla late oblonga, semi- ad sesquipoll. diametro, dentata vel denticulata, utrinque (in siccis) conspicue venosa. *Umbellæ* compositæ, maximæ usque ad 15-radiatæ et 5 poll. diametro; radii umbellarum terminalium sæpe $1\frac{1}{2}$–$2\frac{1}{2}$ poll. longi; bracteæ breves, lineares,

* Named after Capt. E. Stratton, H.M. 22nd Foot, who was killed in action at Kandahar on Sept. 1, 1880.

cito deciduæ; umbellulæ multifloræ, pedicellis gracilibus, brevibus; bracteolæ parvæ, lineari-subulatæ. *Flores* parvi, luteo-virides; calycis dentes obsoleti; petala æqualia, ovato-acuminata, apice inflexa; discus majusculus, margine undulatus; styli per anthesin erecto-patentes, demum reflexi. *Fructus* (maturus non visus) oblongus, 4–5 lineas longus, dorso compressus, jugis primariis alatis, lateralibus late alatis; valleculæ univittatæ; commissura bivittata.

From Mount Síka-rám westwards to Mount Serátígah, growing out of the clefts of rocks, at from 9000 to 13,000 feet.

Used as a vegetable by the natives, in its raw state as well as cooked. Distributed as *Ligusticum* sp. in my former collection.

81. **Ferula communis**, *Linn.*

In the Hariáb district, under the shelter of trees or rocks, on the hills, at an altitude of 10,000 feet. Occurs as an occasional plant, and not, as is usual with the Umbelliferæ of these parts, in great patches.

234, 292,=738, 848, 930, 948 (1879). **Heracleum propinquum**, *Aitchison & Hemsley*, n. sp. Aff. *H. Thomsoni*, sed differt foliis glabris, segmentis angustioribus, vittis omnibus usque ad basin attingentibus.

Herba perennis, fere glabra, caulibus gracilibus, pauciramosis, sæpius 1–1½ ped. altis, interdum humilioribus. *Folia* gracilia, petiolata, rigida, glabra, circumscriptione ovato-oblonga, usque ad 6 poll. longa, bipinnata, segmentis ultimis angustis 3–5-lobatis, nonnullis integris acutis. *Umbellæ* compositæ (in speciminibus depauperatis interdum simplices) maximæ 12–15-radiatæ et 2 poll. diametro; radii puberuli, usque ad sesquipoll. longi, sed plerumque breviores; bracteæ paucæ, lineares, basi dilatatæ, scariosæ; umbellulæ multifloræ, pedicellis brevibus fere filiformibus; bracteolæ lineares, puberulæ, pedicellos æquantes vel excedentes. *Flores* parvi, albi; calycis dentes obvii; petala inæqualia, exteriora alte obcordata; styli longiusculi, per anthesin patentes, dein arcte recurvi. *Fructus* puberulus, oblongo-ellipticus, circiter 3 lineas longus, anguste alatus, marginatus; valleculæ univittatæ; commissura bivittata, vittis omnibus linearibus usque ad basin attingentibus.

Kuram and Hariáb districts, at an altitude of from 9000 to 12,000 feet. Akrobat pass, Griffith 1014 *a*, and 2622 Kew distribution. Distributed as *Peucedanum* sp. in my former collection.

760 (1879). **H. leucocarpum**, *Aitchison & Hemsley*, n. sp. Sparse pilosulum, foliis ampliusculis (ternatis ?) bipinnatifidis vel infra bipinnatipartitis, segmentis ultimis oblongis subduplicato-dentatis, umbellis circiter 25-radiatis, fructu obovato-oblongo late circumalato, ala alba, vittis omnibus linearibus semen æquilongis.

Herba perennis, sparse pilosula, caule crassiusculo, sulcato, 3–4 ped. alto, apice pauciramoso. *Folia* tenuia, ampliuscula (basi ternata, segmentis

bipinnatifidis -partitisque ?), parte superiore bipinnatifida, infra medium bipinnatipartita, segmentis ultimis oblongis, acutis, subduplicato-dentatis, 4–6 poll. longis. *Umbellæ* compositæ, maximæ ad 25-radiatæ et 8 poll. diametro ; radii usque ad 4 poll. longi ; bracteæ nullæ ; umbellulæ multifloræ, floribus parvis, albis, graciliter pedicellatis ; bracteolæ paucæ, lineares ; calycis dentes obvii ; petala inæqualia, exteriores late obcordatæ ; styli per anthesin suberecti, demum reflexi. *Fructus* obovato-oblongus, 5–6 lineas longus, dorso leviter puberulus, late circumalatus (pericarpio infra semina longe producto), ala tenui, alba, glabra ; valleculæ univittatæ ; commissura bivittata, vittis omnibus linearibus, fere æquilongis, semini æquilongis.

Kuram district, sides of fields, near water, at 7000 feet ; July.

ARALIACEÆ.

267. **Aralia cachemirica,** *Decne.*

In the Malána valley, under birch forests, along with *Actæa* &c., at an altitude of from 9000 to 10,000 feet.

GAMOPETALÆ.

RUBIACEÆ.

Aitchisonia, *Hemsley,* Pæderiearum genus novum. *Flores* dimorphi. *Calycis* limbus fere obsoletus. *Corolla* elongato-infundibularis, tubo gracili intus glabro, fauce nuda ; limbi lobi 5, valvati, patentes. *Stamina* 5, inæqualia, 2 fauci inserta, breviter exserta, 3 tubo inclusa, quorum 1 altius affixum est, filamentis brevibus ; antheræ dorso affixæ, lineari-oblongæ, omnia (?) polliniferæ. *Ovarium* didymum, apice bilobum, papillosum, 2-loculare, strato exteriore utriculoso, interiore membranaceo, ovulum arcte amplectente ; stylus filiformis, stigmatibus 2, nunc exsertis nunc inclusis ; ovula in loculis solitaria, e basi erecta, anatropa. *Fructus* 2-coccus, papillosus ; cocci breviter 2–3-cornuti, utriculosi, strato interiore demum soluto. *Semina* erecta, oblonga, testa membranacea ; embryo in axi albuminis rectus, elongatus, cotyledonibus oblongis, radiculam æquantibus, radicula infera.—*Suffrutex* scabridus, contusus fœtidus. *Folia* opposita, breviter petiolata, ovato-lanceolata. *Stipulæ* amplæ, integræ, scariosæ, persistentes. *Flores* rhaphidibus maximis notati, ad apices ramorum ramulorumque densissime cymoso-congesti, singulatim involucellati, sessiles, involucellis cupulatis, laceratis, invicem arcte imbricatis.

260, 272. **A. rosea,** *Hemsley,* n. sp. (Plate XIV. figs. 1–5.) *Suffrutex* densissime ramosus, usque ad bipedalis, ramis gracilibus teretibus. *Folia* 9–12 lineas longa. *Flores* rosei, 6–8 lineas longi ; corolla fugax. *Fructus* vix 2 lineas longus.

This genus has the didymous fruit of the *Stellatæ* associated with opposite leaves and conspicuous interpetiolar persistent sti-

pules. In habit and many of its characters it is allied to *Leptodermis* and *Putoria*, near which genera it should be placed. It is also closely allied to some of the species referred to *Gaillonia*, e. g. *G. Bruguieri*, differing in the free stipules, involucrate flowers, dorsifixed anthers, and basifixed ovules.

In the Kuram district, at the base of the Saféd-koh range along the low hills, at an altitude of from 6000 to 7000 feet.

A shrub from 1 to 2 feet in height, very labiate in its general appearance, and growing in dense clumps that average 6 to 8 feet across, kept in a cushion-like form from the continuous browsing of sheep and goats. The flowers are produced in clusters of five or six, in terminal heads nearly simultaneously over the whole plant, of a rose-pink colour. When in full bloom, the plant is very lovely; but this does not last long, as the corollas are extremely fugacious. Yet, notwithstanding the short period of its beauty, I feel sure it would prove a good acquisition to the floriculturist.

501. **Gaillonia hymenostephana,** *Jaub. & Spach.*

From Thal to Alizai. Very profuse amongst the low hot hills below 3000 feet altitude.

Apt to be overlooked, owing to its scraggy leafless habit, until the development of its coloured calyces, which at once attract attention.

199,=797 (1879). **Galium Mollugo,** *Linn.*

G. asperifolium, Wall., is reduced to this in the 'Flora of British India.'

37, 156 (1879). **G. tricorne,** *Linn.,* was distributed as *G. Aparine,* Linn.

631 (1879). **Asperula pycnantha,** *Boiss.*

Valerianeæ.

98, 192 (1879). **Valeriana sisymbriæfolia,** *Desf.*

Ali-khél, under bushes, common; April.

59, 219 (1879). **Valerianella sclerocarpa,** *Fisch. & Mey.*

Kuram district, on dry stony soil, at 6000 feet, common.

Dipsacaceæ.

641, 642 (1879). **Cephalaria Syriaca,** *Schrad.*

Shálizán; June.

707 (1879). **Scabiosa arvensis,** *Linn.*, var.

Kaiwás; July.

883 (1879). **S.** (§ **Pterocephalus**) **afghanica,** *Aitchison & Hemsley in Journ. Linn. Soc.* xviii. p. 67. (Plate XV. figs. 1–4.)

4, 34, 174,=82 (1879). **S. Candolliana,** *Wall.*

Not common at Thal, becoming more so on reaching Badish-khél, whence it is excessively common throughout the Kuram and Hariáb districts, and very characteristic of the shingle-plains of Kuram, at an altitude of from 3000 to 7500 feet.

It has a large woody rootstock, around which are clusters of short leaves, from amongst which spring up slender flowering stems averaging from 1 to 2 feet in height; they are almost leafless, and bear at their extremities usually only one large flower-head; the flowers are of a bright lavender-colour. These flower-heads, owing to their extremely slender stems, which are not easily detected at a short distance, seem to float gracefully in the air at every breath of wind, resembling butterflies rather than flowers.

COMPOSITÆ.

306,=901 (1879). **Aster lacunarum,** *Aitchison & Hemsley,* n. sp. (Plate XVI. figs. 1–5.) Humilis, ramosus, dense foliosus, foliis parvis linearibus, capitulis minimis, involucri bracteis 3–4-seriatis ligulas fere æquantibus, acheniis compressis pubescentibus, pappi setis 1-seriatis basi connatis deciduis.

Herba perennis vel biennis, habitu foliisque *Alyssi maritimi,* ramosa, 2–4 poll. alta, glabra, ramis graciliusculis. *Folia* linearia, usque ad 1 poll. longa. *Capitula* ad apices ramulorum solitaria, circiter 3 lineas diametro, radiata; involucri bracteæ 3–4-seriatæ, lanceolato-oblongæ, ligulis paullo breviores, acutæ, interiores scariosæ; receptaculum leviter foveolatum. *Flores* radii rubro-purpurei, circiter 15, 1-seriatæ, ligulis angustis in siccis revolutis; disci numerosi, minimi, corollis quam pappus brevioribus. *Achenia* oblonga, compressa, ecostata, pubescentia; pappi setæ scabræ, 1-seriatæ, basi leviter connatæ, deciduæ.—A. roseus, *Stev.? Aitch. in Journ. Linn. Soc.* xviii. p. 68.

Kuram district, common on the shingle at the sides of streams, at an altitude of from 4000 to 6000 feet.

Distributed under 901 (1879) as *Aster roseus,* Stev.?

323,=812 (1879). **A. pseud-Amellus,** *Hook. fil.,* was distributed as *A. Amellus,* Linn.

920 (1879). **Brachyactis umbrosa,** *Benth.,* was distributed as *B. pubescens,* Aitch. & C. B. Clarke.

484. **Conyza ægyptiaca,** *Aiton.*

Between Shinak and Badish-khél, on the sides of watercourses.

530. **Pluchea lanceolata,** *Wall.*

Between Thal and Chaprí, on peculiar clay soil, very local.

1224 (1879). **Filago germanica,** *Linn., ex Fl. Brit. India,* was distributed as *F. arvensis,* Linn.

914 (1879). **Anaphalis contorta,** *Hook. fil. ex Fl. Brit. India,* was distributed as *A. tenella,* DC.

801, 1223 (1879). **A. virgata,** *Thoms.,* var.

With rose-coloured bracts.

9. **Lasiopogon lanatum,** *Cass.*

Kuram district, on the shingle-plains near Shálizán, in localities where there is clay-soil on which water collects, at an altitude of from 4000 to 5000 feet.

The plant looks like a collection of small balls of cotton, or some gigantic mildew.

404. **Phagnalon niveum,** *Edgew.*

The specimens nos. 298, 229 (1879), distributed as *P. denticulatum,* Decne., and no. 564 (1879), as *P. acuminatum,* Boiss., are all this species.

266 (1879). **Gnaphalium pulvinatum,** *Delile,* was distributed as *G. crispatulum,* Delile.

976 (1879). **Inula rupestris,** *Aitchison & Hemsley,* n. sp. Aff. *I. multicaulis,* Fisch. & Mey., differt foliis scabridis, capitulis discoideis, acheniis omnino hirsutis quam pappus multo brevioribus.

Suffrutex ramosissimus, 12–18 poll. altus, ramis ramulisque gracilibus, scabridis. *Folia* sessilia, rigida, lineari-oblonga vel linguæformia, usque ad 2½ poll. longa, apice callosa, obtusiuscula, basi angusta, integra, utrinque scabrida. *Capitula* flava, discoidea, 3–4 lineas diametro, ad apices ramulorum solitaria; involucri bracteæ pallidæ, scarioso-herbaceæ, ovato-lanceolatæ, acutæ, ciliolatæ, exteriores gradatim breviores; receptaculum planum. *Flores* involucrum paullo excedentes. *Achenia* brevia, omnino hirsuta; pappi setæ circiter 20, scabridæ, corolla paullo breviores.

Alikhél, profuse; August. Distributed as *I. caspia,* Blume.

431. **Pulicaria vulgaris,** *Gært.*

Near Kuram, on the sides of rivulets and in rice-fields, at an altitude of 4000 feet. Flowers yellow.

Helianthus annuus, *Linn.*

Cultivated in most gardens.

572 (1879). **Achillea micrantha,** *Bieb.,* was distributed as *Tanacetum millefolium,* Fisch. & Mey.

60, 245 (1879). **A. Santolina,** *Linn.,* was distributed as *A. leptophylla,* Bieb.

393. **Chrysanthemum Griffithii,** *C. B. Clarke.*

Base of Mount Síka-rám, in the deep gorges, growing from the clefts of rocks, at an altitude of 9000 to 10,000 feet.

A shrub, with a stem from 2 to 3 feet in height, throwing out a profusion of flowering shoots, each bearing one (or two) large handsome flower-heads, having a deep pure-white ray with a greenish-yellow disk. Flowers in July.

366,=820 (1879). **Tanacetum Fisheræ,** *Aitchison & Hemsley,* n. sp. Suffruticosum, foliis parvis rigidis pinnatis, segmentis angustissimis interdum pungentibus, capitulis discoideis solitariis, acheniis costatis, pappi palea unica magna.

Suffrutex glabrescens, ramosus, ramis graciliusculis, rigidis, usque ad 9 poll. longis. *Folia* rigida, petiolata, imparipinnata, usque ad 1 poll. longa sed sæpius breviora, segmentis utroque 2–5, teretibus, interdum pungentibus. *Capitula* solitaria, pedunculata, discoidea, multiflora, campanulata, 4–6 lineas diametro, flava; involucri bracteæ 3–4-seriatæ, scarioso-herbaceæ, ovatæ, obtusissimæ, atro marginatæ; receptaculum subplanum, leviter alveolatum. *Flores* involucrum vix excedentes, eglandulosi; corolla late cylindrica; antheræ basi brevissime caudatæ. *Achenia* (matura non visa) costata, glabra; pappi palea unica interior magna, subquadrata, apice lacerata.

In the Hariáb district, Mount Síka-rám, Serátígah, and Sergal, at an altitude of from 10,000 to 13,000 feet. Also collected by Griffith in the Bolan pass and elsewhere (941 and 3213).

A very tortuous shrub, much browsed upon by goats and sheep.

378. **Artemisia Falconeri,** *C. B. Clarke.*

Hariáb district, near the rock of Sergal, at an altitude of 8000 feet.

406. **A. Roxburghiana,** *Bessn.,* var. **purpurascens,** *Jacq.*

In the Hariáb district, at 8000 feet, August.

342, 392. **Senecio pedunculatus,** *Edgew.*

In the Kuram and Hariáb districts, in stream-beds, where there was a small amount of moisture throughout the summer, at an altitude of from 6500 to 9500 feet.

548. **Echinops echinatus,** *DC.*

Near Shinak, on hot stony ground, not common.

971 (1879). **Cousinia** (§ **Squarros**) **aptera,** *Aitchison* *Hemsley,* n. sp. Aff. *C. erinaceæ,* a qua differt segmentis foliorum angustioribus, foliis caulinis non decurrentibus, acheniis maculosis nec transverse rugulosis.

Herba biennis vel perennis, ramosa, 6–9 poll. alta, ramis divaricatis, gracilibus, apteris, plus minus floccosis, oligocephalis. *Folia* subsessilia, an-

guste pinnatifida, longiora 3–4 poll. longa, præcipue subtus floccoso-araneosa; caulina non decurrentia, segmentis distantibus, angustis, apice aculeatis. *Capitula* subsessilia, ovata, absque spinis circiter 6 lineas diametro, pleiantha; involucri bracteæ numerosissimæ, maximam partem squarrosæ, inferne araneosæ, anguste subulato-spinosæ, arcuato-recurvæ, spinis longioribus 6 lineas longis, intimæ erectæ, omnino scariosæ, lanceolatæ, acute acuminatæ, margine ciliolatæ; receptaculum convexum, setis lævibus. *Flores* citrini, involucro breviores; filamenta glabra. *Achenia* obovato-oblonga, 1½–2 lineas longa, compressa, leviter costata, maculosa; pappi setæ breves.

Near Ali-khél, in fields, at 7000 feet; flowers yellow.

Equal to no. 775 Griffith's Journal, and 3268 Kew distribution, Afghanistan.

372, 383,=921 (1879). **Cousinia auriculata**, *Boiss.*?

Hariáb district, on the spurs of Mount Síka-rám, at an altitude of from 10,000 to 14,000 feet.

My specimens are much more woolly, with larger and handsomer flower-heads than the type; but the achenes are identical.

10, 381,=362, 504, 1233 (1879). **C. buphthalmoides**, *Regel* (descrip amplif.). *Herba* biennis?, radice tuberosa, caulibus 3–18 poll. altis, ramis divaricatis, sæpius 1-cephalis. *Folia* radicalia subsessilia, lyrato-pinnatifida, circiter semipedalia, subtus albo-araneoso-tomentosa, supra parce araneosa, marginibus aculeolata, lobis lateralibus utrinque 4–6, parvis, ovato-oblongis, terminali magno (usque ad 3 poll. longo et 2½ poll. lato) ovato-deltoideo.—*Regel et Herder, Pl. Semenov. Contin.* iii. p. 53.—C. auriculata, *Hook. Fl. Brit. Ind.* iii. p. 360, *non Boiss.*

Kuram and Hariáb districts, from the shingle-plains of Kuram, through the pine-forests to the Hariáb, at an altitude of from 4000 to 9000 feet.

It has a curious radish-shaped root; and when the flower-heads have fully come to maturity, the plant is so altered in appearance that one can scarcely believe the two stages of growth belong to the same species.

Griffith's Journal nos. 793, 794, 795, 798, 991, 996, and Kew distribution nos. 3269, 3270, 3271, Afghanistan, belong to this species.

371. **C. pinarocephala**, *Boiss.* (*fide Boiss.*).

In the Hariáb district, at the base of Mount Síka-rám, from 9000 to 12,000 feet, profuse.

358,=922 (1879). **C.** (§ **Alpinæ**) **carthamoides**, *Aitchison & Hemsley*, n. sp. (Plate XVII. figs. 1–7.) Fere omnino glabra, caulibus erectis gra-

ciliusculis 1–5-cephalis, foliis pinnatifidis, involucro araneoso, bracteis numerosis spinis erecto-patentibus armatis, acheniis ecostatis compressis, pappo brevi.

Herba perennis vel biennis, erecta, 1–2 ped. alta, fere omnino glabra, caulibus graciliusculis, apteris, striatis, interdum ad nodos leviter araneosis, 1–5-cephalis. *Folia* coriacea, rigida, luteo-viridia (saltem in siccis) glabra, nitida, pinnatifida, spinosa, usque ad 6 poll. longa et 1½ poll. lata, prominenter nervosa; radicalia petiolata; caulina sessilia, amplexicaulia. *Capitula* nunc solitaria, nunc 2–5 aggregata, subglobosa, absque spinis ad 1½ poll. diametro; involucri bracteæ numerosæ, exteriores araneosæ, basi latæ, spinis rectis 6–9 lineas longis, erecto-patentibus; interiores scariosæ, lineares, acuminatæ, floribus breviores, dorso atrofuscæ; receptaculum convexum, setis barbellatis. *Flores* numerosissimi, purpurei; filamenta glabra; antherarum appendices leviter laceratæ. *Achenia* ecostata, obovato-oblonga, compressa, maculosa, lævia, glabra; pappi setæ paucæ, barbellatæ, achenio multo breviores.

Hariáb district, base of Mount Síka-rám, at an altitude of from 9000 to 12,000 feet.

The leaves, on drying, become quite yellow.

359, = 923 (1879). **Cousinia** (§ **Alpinæ**) **elegans**, *Aitchison & Hemsley*, n. sp. (Plate XVIII. figs. 1–8.) Aff. *C. multilobæ*, sed caulibus simplicibus sæpissime monocephalis, capitulis majoribus, involucri bracteis non recurvis, etc.

Herba perennis, caulibus floccosis, simplicibus, erectis, 10–15 poll. altis, sæpissime monocephalis (interdum capitula 2, quorum 1 multo minus), apteris. *Folia* subtus niveo-floccoso-araneosa, inferiora petiolata, usque ad 9 poll. longa et 2 poll. lata, omnia pinnatipartita, segmentis multijugis, 2–3-partitis, supra glabris, costis latis, prominentibus, pallidioribus (stramineis) in spinas rigidas abeuntibus. *Capitula* subglobosa, absque spinis usque ad 2 poll. diametro, polyantha; involucri bracteæ exteriores 15–20, basi latæ, araneosæ, duræ, acerosæ, rectæ, patentes, flores multo excedentes, ad 1½ poll. longæ; interiores numerosiores scariosæ, lineares, rectæ, acutæ, ciliolatæ, floribus breviores; receptaculum convexum, setis pilosis. *Flores* purpurei; filamenta glabra; antherarum caudæ paucilaceratæ. *Achenia* valde immatura tantum visa; pappi setæ breves, scabridæ.

In the Hariáb district, on the ridges of Mount Síka-rám, from 9000 to 12,000 feet, common.

353, 375, 376, = 1234, 1226 (1879). **C.** (§ **Alpinæ**) **scala**, *Aitchison & Hemsley*, n. sp. (Non eadem ac 3326, 3327, *Griffith.*) Facie foliis *C. multilobæ* similis, sed distincta capitulis numerosis cymoso-paniculatis et involucri bracteis interioribus apice membranaceo-dilatatis.

Herba perennis vel biennis, erecta, usque ad 4 ped. alta, fere omnino

glabra, caulibus crassiusculis, subsimplicibus, apice laxe polycephalis. *Folia* omnia sessilia, usque ad 9–12 poll. longa et 2½–3 poll. lata, pinnatipartita, segmentis multijugis, sæpius 2–3-partitis, lobis acerosis. *Capitula* numerosa, pedunculata, laxe cymoso-paniculata, subglobosa, absque spinis circiter 1½ poll. diametro; involucri bracteæ numerosæ, exteriores parce araneosæ, e basi lata acerosæ, acubus rectis vel plus minus arcuatis, usque ad 1 poll. longis; interiores membranaceo-scariosæ, flores subæquantes, apice dilatatæ; receptaculum leviter convexum, setis parte superiore obscure barbellatis. *Flores* numerosissimi, purpurei; filamenta glabra. *Achenia* (immatura tantum visa) glabra, compressa, ecostata, 2-alata.

In the Hariáb district, near cultivation, from 7000 to 9000 feet; very common.

No. 850 (1879) is too young for determination; but seems to be a state of this plant with sessile flower-heads. It is certainly not *C. racemosa*, Boiss.

435. **Cnicus lanceolatus**, *Willd.*

Kuram district, in fields, at 4000 feet altitude.

970 (1879). **C.** sp. This was distributed as *C. horridus*, Bieb. It is not that plant, but seems to be a very near ally of Griffith's Journal nos. 775 and 993, distribution number 3308, and of *C. echinatus*, Lois.

319, 888, 913 (1879). **Saussurea candicans**, *C. B. Clarke*, was distributed as *S. hypoleuca*, Spreng.

386. **Jurinea leptoloba**, *DC.*

Hariáb district, from 8000 to 9000 feet. Flowers from pink to a light purple; July.

721, 392 (1879). **Pertya Aitchisoni**, *C. B. Clarke in Journ. Linn. Soc.* xviii. p. 72. (Plate XIX. figs. 1–5.)

48. **Crepis**, sp.

In the Hariáb district, in pine-forests and under the shelter of large rocks, at an altitude of 8500 feet.

945 (1879). **C.** sp. was distributed as *C. Kotschyana*, Boiss.; but it is not that species.

312, 562, 839, 859 (1879). **Phæcasium lampsanoides**, *Cass.*, distributed as *Crepis* sp.

717 (1879). **Lactuca Scariola**, *Linn.*, was distributed as *L. auriculata*, DC.

329 (1879). **L. auriculata**, *DC.*, was distributed as *L.* sp.

997 (1879). **L. macrorhiza**, *Hook. f.*, was distributed as *Prenanthes* sp.

P 2

997,1 (1879). **Lactuca rapunculoides,** *C. B. Clarke*, var., was distributed as *L.* sp.

17, 30. **Launæa nudicaulis,** *Less.*

From Thal to Shálizán, in dry stream-beds, under 5000 feet; very common.

589 (1879). **L.** sp. nov.?, was distributed as *Microrhynchus asplenifolius*, DC.

It occurs in the Hariáb district, growing from the crevices of huge rocks, associated with *Dionysia* and *Parietaria*, at an altitude of from 7000 to 8000 feet.

An elegant tender annual, scarcely over 4 inches in height. It grows in clusters, and, interlacing its branches with the others of its kind, produces the soft moss-like cushions so characteristic of the rocks of that part of the country, where there are few lichens or mosses, and still fewer ferns to vary the colouring.

I regret that there is no ripe fruit amongst my specimens to enable me to describe this interesting plant.

CAMPANULACEÆ.

279. **Campanula aristata,** *Wall.*

Collected a few specimens only on the Nangrár pass, at an elevation of 11,000 feet; July.

325, 410, = 941 (1879). **C. cashmiriana,** *Royle.*

In the Kuram and Hariáb districts; common on damp rocks, at an elevation of from 7000 to 9000 feet.

395. **C. cashmiriana,** *Royle*, var. **evolvulacea,** *C. B. Clarke in Hook. Fl. Brit. Ind.* iii. p. 441.

From the same locality as the last.

382, = 941 A (1879). **C. ruderalis,** *Aitchison & Hemsley*, n. sp. (§ Medium, triloculares-perennes-exappendiculatæ-saxicolæ, *Boiss. Fl. Or.* iii. p. 893.) *Herba* perennis, humilis, hispidula, dense ramosa, ramis gracilibus, adscendentibus, usque ad 6 poll. longis, 1–3-floris, sæpius 1-floris. *Folia* sæpius conferta, subsessilia, lanceolato-oblonga, obovata, vel interdum fere orbicularia, plerumque 4–8 lineas longa, integra vel obsolete denticulata. *Flores* rubro-cærulei, pedunculati, anguste campanulati, 5–6 lineas longi, patentes; calycis hispiduli lobi ovati, acuti, sinibus omnino nudis; corollæ lobi lati, obtusi vel rotundati; filamenta basi dilatata. *Capsula* semisupera, obconica; semina numerosissima, minuta, oblonga, nitidissima.

In the Hariáb district, on hot south and west exposures, growing in rubble, at an elevation of from 9000 to 12,000 feet.

ERICACEÆ.

344 (1879). **Rhododendron Collettianum,** *Aitchison & Hemsley in Journ. Linn. Soc.* xviii. p. 75. (Plate XX. figs. 1–8.)

457 (1879). **R. afghanicum,** *Aitchison & Hemsley,* loc. cit. (Plate XXI. figs. 1–7.)

PLUMBAGINEÆ.

361. **Acantholimon** sp. (nov.?) near *A. roseum,* Boiss.

Hariáb district, from 10,000 to 12,000 feet. Flower-heads almost sessile.

A. (§ **Armeriopsis**) **calocephalum,** *Aitchison & Hemsley in Journ. Linn. Soc.* xviii. p. 77. (Plate XXII. figs. 1–4.)

439. **Statice Griffithii,** *Aitchison & Hemsley,* n. sp. (Plate XXIII. figs. 1–4.) Aff. *S. cabulica,* differt foliorum rosulis laxioribus, foliis longioribus angustioribus, scapis gracilioribus simplicibus vel 2–4-ramosis, bracteis bracteolisque minoribus.

Herba perennis, scaposa, pauciramosa, ramis brevissimis, crassis. *Folia* lepidota, rosulata, obovata vel linguæformia, usque ad 2½ poll. longa, obsolete trinervia, apice aristulata, deorsum attenuata. *Scapi* graciles, simplices vel pauci et stricte ramosi, 8–20 poll. alti, spiculis sæpius 1-floris, sparsis; bractea exterior suborbicularis, mucronata, margine anguste scariosa, ceteræ præter costam scariosæ, interiores apice rotundatæ. *Flores* rosei; calyx appresse hirsutus, breviter 10-lobatus, 5-costatus, lobis obtusis, alternis brevioribus, ecostatis, omnino scariosis; petala integra, apice rotundata; stigmata capitulata.

On the low hills opposite Kuram, to the south of the river; also in the vicinity of Badish-khél and Shinak on similar low hills, at an elevation of from 3000 to 5000 feet; very common.

Griffith, Khyber pass, 4172 and 4173 Kew distribution; J. L. Stewart, Jhelum valley, 3000 feet.

PRIMULACEÆ.

355. **Primula denticulata,** *Sm.,* var. **capitata.**

Hariáb district, common in boggy and spongy meadow-ground that is watered profusely by springs, at an elevation of 8000 feet.

462 (1879). **P. rosea,** *Royle,* var.

This variety has each flower supported on a long slender pedicel; and the tube of the corolla is longer and narrower than that of the type.

58, 71, 110, =323 (1879). **Androsace sempervivoides,** *Jacquem.*, var. **bracteata,** *Watt.*

Kuram and Hariáb districts, very profuse in the open glades of forests, at an altitude of from 7000 to 10,000 feet.

97, =925 (1879). **A. villosa,** *Linn.*

Exposed ridges of Mount Síka-rám, on fine gravel, at an altitude of from 13,000 to 14,000 feet; not very common.

321. **Samolus Valerandi,** *Linn.*

Kuram district, in watercourses near cultivation, at 6500 feet.

Oleaceæ.

44. **Fraxinus xanthoxyloides,** *Wall.*

My specimens distributed last year under the name *F. Moorcroftiana*, Wall., are this plant; I here alter the name, as my plant corresponds to Wallich's type specimen of *F. xanthoxyloides*; his type specimen of *F. Moorcroftiana* is *F. excelsior*, Linn., as I am informed by Mr. C. B. Clarke.

Salvadoraceæ.

524. **Salvadora oleoides,** *Decne.*

Thal, common in the low hills as far as Chaprí.

At a distance this looks like a large spreading bush; but on closer examination it is found to have a short stout trunk, much thicker in proportion to the size of the whole than one would expect.

Asclepiadeæ.

550. **Periploca hydaspidis,** *Falc.*

At Jelamai, near Shinak, in the low hills, at an altitude not above 3800 feet.

Occurs as a large semiscandent shrub with bright-yellow flowers. Except when in flower or fruit, it is quite impossible to distinguish it as it grows from *Ephedra ciliata*, Fisch. & Mey., a common plant of the same region.

485. **Calotropis procera,** *R. Br.*

From Thal to Badish-khél, below 3000 feet, not common.

399, =582 (1879). **Vincetoxicum parviflorum,** *Decne.*, var. **alpina,** *Schott.*

Kuram and Hariáb districts, on hot southern exposures, at an altitude of from 7500 to 8000 feet.

608. **Pentatropis spiralis,** *Edgew.*

Common between Thal and Badish-khél.

511. **Dæmia extensa,** *R. Br.*

From Thal to Alizai, common.

492. **Boucerosia Aucheri,** *Decne.*

Thal to Kuram, amongst large stones, in the clefts of rocks, and at the roots of large bushes, up to an altitude of 4000 feet.

Collected largely, and eaten raw as well as cooked, by the natives.

GENTIANEÆ.

345,=881 (1879). **Gentiana aquatica,** *Linn.*

Hariáb district, in grassy loamy soil that is permeated by spring-water, at 8000 feet; common.

932, 1003 (1879). **G. aurea,** *Linn.*

401. **G. Kurroo,** *Royle.*

Kuram district, on the low outer hills near Shálizán, at an elevation of 7000 feet. In some localities common.

360. **G. micrantha,** *Aitchison & Hemsley,* n. sp. (Plate IX. figs. 1–5.)

Annua, minima, calyce 4-partito corollam excedente, corolla cylindrico-campanulata intus omnino nuda.

Herba annua, gracillima, glaberrima, erecta, vix ramosa, 1–2½ poll. alta. *Folia* opposita, sessilia, tenuia, obovato-oblonga, usque ad 9 lineas longa. *Flores* cærulei, 3–4 lineas longi, breviter pedicellati, 2–8 aggregati; calycis lobi 4, parum inæquales, lineares, acuti, corollam excedentes; corolla cylindrico-campanulata, 4-lobata, intus omnino nuda glabraque, lobis semiorbicularibus, mucronatis, quam tubus paullo brevioribus; stamina 4, basi corollæ inserta; stigmata sessilia. *Capsula* matura non visa.

Saféd-koh range, under the shelter of Juniper bushes, at an altitude of nearly 12,000 feet.

A small slender annual, scarcely 4 inches in height. The flowers hidden within the opposite leaves.

Possibly a small-flowered state of a previously described species.

BORAGINEÆ.

515, 529. **Ehretia obtusifolia,** *Hochst.*

Near Thal; a common shrub with large heads of lavender-coloured or white flowers.

486,=11 (1879). **Heliotropium cabulicum,** *Bunge.*

From Thal to Kuram, not above 5000 feet. Flowers large, few, and usually pure white.

427,=662 (1879). **Heliotropium Eichwaldi**, *Steud.*, was distributed as *H. europæum*, Linn.

From Thal to near Shálizán, up to 5000 feet, not common.

864 (1879). **Trichodesma strictum**, *Aitchison & Hemsley*, n. sp. Aff. *T. mollis*, differt caulibus erectis strictis bipedalibus et ultra, foliis omnibus (?) alternis multo minus hirsutis, hispidulis, floribus numerosis in paniculam terminalem dispositis.

Herba perennis, caulibus angulatis, subsimplicibus, erectis, strictis, 2–3 ped. altis, apice tantum floriferis. *Folia* omnia (?) alterna, sessilia (saltem caulina), ovato-oblonga, 2–3 poll. longa, acuta, basi rotundata nec amplexicaulia, utrinque hispidula, nec densissime molliterque hirsuta ut in *T. molli*. *Flores* speciosi, 12–15 lineas diametro, cærulei, graciliter pedicellati, in paniculas amplas terminales dispositi; calyx basi nec alatus nec angulatus, lobis longe acuminatis; corollæ lobi rotundati, longe caudati; antheræ extus parte inferiore longe barbatæ, supra medium inter se spiraliter tortæ. *Nuculæ* depressæ, marginatæ, scrobiculatæ.

Ali-khél, at 7500 feet.

A handsome herbaceous perennial, growing nearly 3 feet in height, and bearing masses of lovely large blue flowers.

106, 117, 197 (1879). **Omphalodes** (§ **Paracaryum**) **microcarpum**, *Boiss.*

900 (1879). **Cynoglossum micranthum**, *Desf.*, var. **canescens**, *Royle*, distributed as *C. furcatum*, Wall.

46, 175, 243. **C. denticulatum**, *DC.*

From 6000 to 10,000 feet; common.

107. **Echinospermum**, sp.

Mount Síka-rám, Hariáb district, at an altitude of 10,000 feet.

Eritrichium strictum, *Decne.*

The plant distributed without number in 1879 as *E. sericeum*, Royle.

140 (1879). **Rochelia stylaris**, *Boiss.*

The plant distributed as *R. stellulata*, Reichb.

507, 569, 858 (1879). **Lycopsis arvensis**, *Linn.*, distributed as *Anchusa Milleri*, Willd.

192. **Mertensia echioides**, *Hook. fil. & Thoms.* ?

Up the Shend-toí valley, near water, at an elevation of 11,000 feet.

The material is scarcely sufficient for identification.

284, 286. **Myosotis sylvatica**, *Hoff.* ?

Near the Nangrár pass, at 11,000 feet.

45, 235 (1879). **Onosma stenosiphon,** *Boiss.*

From Shinak to Kuram, under 5000 feet; April.

720 (1879). **Arnebia** (§ **Macrotomia**) **speciosa,** *Aitchison & Hemsley in Journ. Linn. Soc.* xviii. p. 81. (Plate XXIV. figs. 1–6.)

Convolvulaceæ.

436. **Ipomœa eriocarpa,** *R. Br.*—I. sessiliflora, *Roth.*

From Thal to Kuram, under 5000 feet; a common weed near cultivation.

15 (1879). **Convolvulus Aitchisoni,** *C. B. Clarke,* n. sp. Suffrutescens, patule fulvo-hirsutus nec sericeus, dense cæspitosus, foliis fasciculatis linearibus; caulibus annuis floriferis ½–4-uncialibus, capitulis bracteatis, sepalis lanceolato-linearibus hirsutissimis.—C. lanuginosus, *Aitch. Cat. Punjab Pl.* 98, *an Lamk.*?

Species *C. lanuginoso* vel *C. Calverti* (Boiss. Fl. Orient. iv. 94) proxima, sed validior, fere hispida.

Herba perennis, basi ramosissima; e ramis plures abbreviati, dense foliati, cæspitem efformant. *Corolla* uncialis. *Ovarium* glabrum; stigmata filiformia, stylo longiora. *Fructus* non visus.—Bracteæ floresque fere similes iis *C. capitati* (Cav. Ic. ii. p. 72, t. 189), sed paullo majores, multo hirsutiores. Species forsan, cum aliis Boissierianis, sub *C. lanuginosum* revocanda.

From Alizai to Habíb-kalla, from 3000 to 6000 feet. Punjab: Jhelum and Salt range, *Aitchison.*

Very characteristic of the open gravel plains, forming almost hummocky woollen patches.

526. **Evolvulus alsinoides,** *L.*

Near Chaprí, common; August.

Solanaceæ.

500. **Solanum coagulans,** *Forsk.*

Thal to Badish-khél, up to 3000 feet, common.

Has a large globose fruit, very like that of some forms of *Solanum Melongena* Linn.

483. **S. xanthocarpum,** *Schrad. & Wendl.*

Between Thal and Badish-khél.

521. **S. gracilipes,** *Decne.*

From Thal to Alizai, under 3000 feet.

Always grows in the shelter of large bushes. Flowers from white to lavender. Fruit, when ripe, bright orange-red.

470. **Physalis minima,** *Linn.*

From Thal to Kuram, a profuse weed in moist cultivated land.

469. **Withania somnifera,** *Dun.*

From Thal to Kuram, not common.

Scrophularineæ.

318, 505. **Linaria ramosissima,** *Wall.*

From Thal to Kuram, on the face of conglomerate cliffs, below 4000 feet altitude; very common.

77,=461 (1879) ex parte. **Scrophularia Scopolii,** *Hoppe.*

In the Kuram and Hariáb districts, at an altitude of from 7000 to 8000 feet, common.

461 (1879) ex parte. **Scrophularia** sp., the same as Griffith's Journal no. 816.

919 (1879). **S.** (§ **Tomiophyllum-lucidæ**) **petræa,** *Aitchison & Hemsley,* n. sp. Humilis, multicaulis, præter calyces glanduloso-puberulos glabra, foliis crassis petiolatis oblongis grosse crenatis, thyrsis densis paucifloris, calycis segmentis angustissime scarioso-marginatis.

Herba perennis, multicaulis, 3–5 poll. alta, præter calyces glabra, caulibus gracillimis, teretibus. *Folia* opposita, longiuscule petiolata, crassa, oblonga vel ovato-oblonga, usque ad sesquipoll. longa, sæpissime obtusa vel rotundata, grosse crenata, venis primariis tantum conspicuis. *Flores* purpureo-virides, 4–5 lineas longi, breviter pedicellati, in thyrsos terminales parvos densiusculos dispositi, bracteis linearibus crassis; calycis segmenta glanduloso-puberula, crassa, oblongo-obovata, concava, vix vel angustissime scarioso-marginata; anthera sterilis reniformis, undulata; genitalia inclusa. *Capsula* sphæroidea, rostrata; semina scrobiculata.

Hariáb district, amongst rock débris, at an altitude of from 11,000 to 14,000 feet.

A dwarf species with extremely large flowers.

195, 664 (1879). **Veronica Anagallis,** *Linn.,* was distributed as *Veronica Beccabunga,* Linn.

609. **V. biloba,** *L.*

Kuram district, under the shade of large trees, at 5000 feet altitude.

38. **V. cardiocarpa,** *Walp.*—V. Griffithii, *Benth.*

Kuram district. Probably a form of *V. biloba,* Linn.

198,=238, 331 (1879). **V.** (§ **Chamædrys**) **rupestris,** *Aitchison & Hemsley,* n. sp. (Plate XXV. figs 1–5.) Perennis, basi suffruticosa,

facie *V. Teucrii*, sed differt calyce 4-partito, segmentis subæqualibus, capsula ovato-oblonga apice obtusa; etiamque aff. *V. lanosæ*, a qua sat differt racemis lateralibus capsula quam calyx longiore.

Herba perennis, multicaulis, basi suffruticosa, caulibus gracilibus, teretibus, adscendentibus, junioribus sæpe albo-villosulis, 6–12 poll. longis. *Folia* opposita, subsessilia, tenuia, glabra vel glabrescentia, ovato-lanceolata vel oblonga, 9–18 lineas longa, utrinque (interdum argute) paucidentata. *Flores* cærulei, 6–8 lineas diametro, racemis sæpius 2 in axillis foliorum superiorum alternis vel oppositis (interdum pseudoterminales), pedunculatis, usque ad 3 poll. longis, bracteatis; bracteæ lineari-oblongæ, obtusiusculæ, pedicellos æquantes; pedicelli calyx subæquantes, fructiferi erecti; calyx 4-partitus, lobis fere æqualibus, linearibus, subobliquis; corollæ lobi leviter inæquales; stamina longa, filamentis filiformibus, antheris cordiformibus; stylus stamina æquans. *Capsula* (immatura tantum visa) anguste ovato-oblonga, calycem excedens, circiter 3 lineas longa, puberula, loculis pleiospermis; semina convexa.

Kuram district, on shaded moist localities, at from 8000 to 11,000 feet altitude. Saféd-koh, Collett no. 112. Lahul, Jaeschke. Herb. Falconer no. 784, Kew distribution in part. Unfortunately the portion of the plants drawn does not represent the characteristic lateral racemes. A showy species.

975 (1879). **Leptorhabdos virgata,** *Benth.*

My plant is not nearly so glandular as the type.

220, 285,=779 (1879). **Pedicularis bicornuta,** *Klotzsch.*

Kuram and Hariáb districts, on grassy slopes at from 10,000 to 12,000 feet in great profusion. Flowers large, yellow, very handsome.

108,=487 (1879). **P. pycnantha,** *Boiss.*

Kuram and Hariáb districts, in pine-forests and on dry hill-sides, at from 8000 to 12,000 feet altitude.

P. sp. (without number), was distributed as *P. tenuirostris,* Benth.; but it is not that species.

Shend-toí; August.

OROBANCHACEÆ.

214. **Orobanche Epithymum,** *DC.*

Kuram district, growing on a Labiate at 10,000 feet altitude.

85, 161, 350,=934, 934 *a*, 267, 893 (1879). **O.** sp.

Kuram and Hariáb districts; common everywhere, growing on two species of *Artemisia*, at an altitude of from 6000 to 10,000 feet.

The colour of the flower varies from a dirty white to a dark purple.

Bignoniaceæ.

489. **Tecoma undulata,** *G. Don.*

From Thal to Badish-khél, on the low hills and in ravines, not above 3500 feet altitude.

Occurs as a large bush or small tree. Flowers from a pale yellow to a deep orange, very large and attractive, the continuous resort of a small steel-blue honey-bird.

Pedalineæ.

519. **Sesamum indicum,** *L.*

From Thal to Kuram. The plants I collected originated, no doubt, from seeds left on the road-sides by travellers who used them for food, because I never saw the plant except in the vicinity of roads and villages. It is not cultivated at all in the Kuram valley.

Acanthaceæ.

471. **Justicia peploides,** *T. Anders.*

From Thal to Kuram, in rice-fields, common.

478. **Dicliptera Roxburghii,** *Nees.*

From Thal to Badish-khél.

Verbenaceæ.

508,=41 (1879). **Lantana alba,** *Linn.*

From Thal to Badish-khél, common. A very variable plant as to size and number of flowers in each flower-head, also as to the form, size, and consistency of its leaves; all the variations due to whether it has been growing in hot dry open places, or with moisture and in the shade of bushes.

309. **Lippia nodiflora,** *Rich.*

From Thal to Kuram, near water, very common.

446. **Vitex Negundo,** *L.*

From Thal to Kuram and Shálizán, near the river's bank or on its tributaries, forming a large bush; common.

Labiatæ.

451. **Lycopus europæus.**

At Kuram, in the ditches round fields, common.

499. **Salvia pumila,** *Benth.*

From Thal to Badish-khél, on dry stony country. Greedily browsed by goats and sheep.

397. **Nepeta pubescens,** *Benth.*

Hariáb district, amongst wet gravel, at 9000 feet altitude.

242, 302,=715, 768 (1879). **N. spicata,** *Benth.*

Kuram district, common at 9000 to 11,000 feet altitude.

447 (1879). **N.** (§ **Longifloræ,** *Boiss.*) **pinetorum,** *Aitchison & Hemsley,* n. sp. Glabrescens, gracilis, calyce subbilabiato, dentibus labii superioris latioribus, fauce parce pilosa, corolla quam calyx duplo longiore, tubo sursum inflato.

Herba perennis, fere glabra, 2–2½ ped. alta, caulibus numerosis, gracilibus, parce ramosis, viridibus, nitidis. *Folia* brevissime petiolata, crassiuscula, cordato-ovata vel cordato-orbicularia, usque ad 1 poll. longa, paucicrenata, obtusissima, venis conspicuis. *Flores* cærulei, cymosi, cymis subtrifloris, pedunculatis, vel superioribus subsessilibus; bracteæ minimæ, molliter subulatæ; calyx glanduloso-hirsutus, 15-nervius, leviter curvatus, sursum ampliatus, subbilabiatus, dentibus latis, patentibus, superioribus brevioribus, acutis, nec setosis nec cristatis, fauce parce pilosa; corolla calyce duplo longior, extus hirsuta, intus glabra, sursum inflata, labiis subæqualibus, postico bifido, antico corrugato; discus crasso-carnosus, antice 1-lobatus. *Nuculæ* oblongo-trigonæ, læves.

Near *N. lamiifolia* and *N. teucriifolia,* differing from both in the teeth of the calyx, as well as in the tube being pilose within, and in other characters. Indeed the ring of hairs in the throat of the calyx would throw it out of the section; but it is otherwise so like these species that it must be associated with them.

Hariáb district from the Péwár-kotal to Káratígah, from 8000 to 11,000 feet. Profuse on the edge of pine-forests. A very showy plant, with large bright lavender-coloured flowers.

It has been raised at Kew, where it flowered in June 1881, from seed collected during 1879.

573 (1879). **Dracocephalum nodulosum,** *Rupr.*

Hariáb district, common from 9000 to 11,000 feet altitude. Flowers June to August.

A very handsome plant, having bright blue to purple flowers. I have not met with it yellow as in the type.

201 (1879). **Scutellaria glutinosa,** *Benth.,* var.?

Kuram and Hariáb districts, from 6000 to 7000 feet altitude. Safėd-koh, Collett no. 39.

It creeps very close to the ground, and has large yellow flowers, with the hood rose-coloured, or sometimes purplish.

537 (1879). **Scutellaria multicaulis**, *Boiss.*

Hariáb district, at 7500 to 8000 feet.

A low stiff shrub. Flowers with long elegant tubes of a light yellow, ending in a bright purple hood. The flowers grow erect, and thus give great character to the plant.

94, 190, 304,=777 (1879). **Phlomis lamiifolia**, *Royle.*—P. bracteosa, *Royle.*

Kuram and Hariáb districts, very profuse on the grassy slopes of streams, at an altitude of from 8000 to 12,000 feet.

This was the plant in which the natives packed the snow to enable them to carry it down the Kuram valley during the hot weather.

16 (1879). **Eremostachys acanthocalyx**, *Boiss.*

70, 82,=449, 486 (1879). **E. speciosa**, *Rupr.*

449. **Teucrium Scordium**, *Linn.*

Near Kuram, on the sides of ditches and moist fields; common.

444. **T.** (§ **Polium**) **incanum**, *Aitchison & Hemsley*, n. sp. Aff. *T. Stocksiani*, a quo differt ramis foliisque brevissime incano-tomentosis, floribus paucioribus majoribus.

Suffrutex densissime ramosus, usque ad 2 ped. altus, undique brevissime incano-tomentosus, ramis gracilibus, internodiis quam folia brevioribus, interdum brevissimis. *Folia* subsessilia, crassa, obovato-oblonga, 4–6 lineas longa, basi cuneata, apice rotundata, parte superiore crenata. *Flores* eburnei, circiter 8 lineas longi, pauci in apices ramulorum congesti; calyx intus extusque pilosulus, latus, subinflatus, leviter obliquus, dentibus fere æqualibus, quam tubum paullo brevioribus; corolla calyce subduplo longior; staminibus exsertis.

Between Thal and Badish-khél, growing gregariously on the low conglomerate hills, at an altitude not above 3500 feet. A small woody shrub about 2 feet in height; flowers a dull white.

Monochlamydeæ.

Nyctagineæ.

479. **Boerhaavia diffusa**, *Linn.*

From Thal to Kuram, on hot exposed stony localities; not common.

Amarantaceæ.

452. **Celosia argentea,** *Linn.*
From Thal to Kuram, a weed of cultivation.

523. **Ærua javanica,** *Juss.*
From Thal to Chaprí.

Chenopodiaceæ.

491 (1879). **Blitum virgatum,** *Linn.*, distributed as *Chenopodium* sp.

Beta vulgaris, *Linn.*
Beetroot was cultivated in the Shálizán gardens; and I saw some splendid specimens of the root. The Afghans are very fond of this vegetable.

450. **Salsola Kali,** *Linn.*
From Thal to Kuram, but not common.

472. **Camphorosma** sp.?
Near Badish-khél, on hot dry clay-soil.

Polygonaceæ.

367. **Polygonum aviculare,** *Linn.*, var.
Hariáb, Mount Síka-rám, at 12,000 feet. Very like *P. recumbens,* Royle.

282. **P. Bistorta,** *Linn.*
On the Nangrár pass, in quantity, at 11,500 feet, varying very greatly as to size.

293. **P. cognatum,** *Meissn.*
Nangrár pass, at 11,000 feet.

433. **P. flaccidum,** *Roxb.*
Near Kuram, in moist localities.

437. **P.** sp.
Locality unknown.

Euphorbiaceæ.

520, 605 (1879). **Euphorbia cœladenia,** *Boiss.*
Ali-khél and Bián-khél, very common on dry clay-fields.

461. **E. indica,** *Lam.*
Near Kuram, August.

64, 261, = 380 (1879). **Euphorbia Thomsoniana,** *Boiss.*

Kuram and Hariáb, very characteristic of the region at the limit of trees, 11,000 to 12,000 feet.

The crushed fruit and leaves employed to destroy vermin, and the root-stalk, after being boiled, used as a purgative.

549. **Buxus sempervirens,** *Linn.*

Between Thal and Badish-khél, on limestone formation, in the low hills, to nearly 4000 feet. Occurs as a large shrub, not a tree. The wood is put to various uses, and is known by the Afghans to be hard and close-grained.

425. **Crozophora tinctoria,** *Linn.*

From Thal to Kuram, as a weed in the vicinity of villages.

518. **Ricinus communis,** *Linn.*

Near Thal; appears as if indigenous amongst the low hills. A somewhat different variety occurs as a weed near cultivation. At Shálizán it is cultivated in gardens for domestic use, the leaves being employed as poultices.

CUPULIFERÆ.

146. **Quercus dilatata,** *Lindl.*

At Ali-khél, and on the Péwár-kotal, from 7000 to 8500 feet altitude. Specimens of the former collection were distributed under 770 (1879) as *Quercus Ilex*, var., collected Ali-khél 22nd July.

How far it is a prevalent tree in the forests, I do not know; for I certainly did not recognize it except on one occasion.

SALICINEÆ.

341. **Salix** sp.

Shend-toí gorge, in the beds of streams at an altitude of from 9500 to 11,000 feet.

GNETACEÆ.

65, = 126 (1879). **Ephedra vulgaris,** *Rich.*

In the Hariáb district, on rocks at 11,000 feet common.

1209 (1879). **E.** sp.

Shálizán, June.

Only the male flowers of this species were collected; and they do not appear to differ materially from those of *E. vulgaris*, Rich.;

but the habit of the plant is so different, that I suspect it may be a distinct species.

496, 537, 537 *b*. **Ephedra ciliata,** *Fisch. & Mey.*

This is reduced by Parlatore and others to *E. Alte*, C. A. Meyer. Judging from the type specimens in the Kew Herbarium, it seems to be a distinct species both in habit and inflorescence.

The male flowers of *C. Alte* are nearly four times as large as those of *E. ciliata*, bearing thicker non-ciliolate scales. My plant has ciliolate scales; the scales of the female flowers are at first green, becoming tinged with a russet brown; the inner scales, which at first only partially cover the seeds, become fleshy, gradually enlarge until they completely enclose the two seeds, and, by the close approximation of their free margin, give the fruit the appearance of being a drupe. The fruit, when ripe, is semitransparent, of a milky white (not red), clearly showing two black seeds occupying the interior.

From Thal to Mandúrí, in the low hills, not above 3500 feet in altitude.

I have collected the same species at Rawul-pindee in the Punjab, no. 536, Salt range no. 6; Stocks, Scinde, nos. 7 and 449; Fleming, Salt range, no. 94; Vicary, Margalla pass near Rawul-pindee.

Coniferæ.

105, 226, = 1210 (1879). **Juniperus recurva,** *Ham.*

Pinus longifolia, *Lamb.*

Cultivated in the cantonments of Kohat. I did not meet with it anywhere in the Kuram or Ḥariáb districts.

P. halepensis, *Mill.*

Kuram district; occurs only as a cultivated tree near a shrine in the village of Zérán, at an altitude of 6500 feet.

MONOCOTYLEDONES.

Petaloideæ*.

Palmaceæ.

Nannorrhops Ritchieana, *Wendl. in Bot. Zeit.* 1879, p. 148. (Plate XXVI. figs. 1–12.)—Chamærops Ritchieana, *Griffith*, See *Journ. Linn. Soc.* xviii. p. 99.

* For the identification of the Petaloideæ I am indebted to Mr. J. G. Baker, F.R.S.

The accompanying woodcut (see p. 141) was drawn from a branched trunk in the museum at Kew, brought home from the Kuram alley, Afghanistan, by me in 1880. Plate XXVI. is a reduced copy of a drawing of a tree growing in the Saharanpur botanic garden, copied by permission of Mr. Duthie, Superintendent of the garden.

Typhaceæ.

600. **Typha angustifolia,** *Linn.*
On the banks of the Kuram river, at Shinak.

531. **T. latifolia,** *Linn.* ?
Between Chaprí and Mandúrí, in shallows on the margin of the Kuram stream. A very large bullrush.

480. **T. Martini,** *T. Thoms. in Herb. Kew., non Jordan.*
Between Shinak and Badish-khél, in rice-fields and pieces of still water ; common.

Aroideæ.

327, 296, =770 (1879). **Arisæma Jacquemontii,** *Blume.*
Kuram district, in moist shady woods, at an elevation of from 7000 to 8000 feet ; not uncommon.

Orchideæ.

413. **Habenaria brachyphylla,** *Lindl.*
Darban valley, Kuram district, on rich loam in woods, at an altitude of 7500 feet. Flowers bright green.
Equal to 1036 Falconer, Herb. Kew.

34, =1238 (1879). **Dienia muscifera,** *Lindl.*
Shend-toí valley, on rich loam in oak-forests, at 9500 feet altitude ; rare.

Liliaceæ.

596 (1879). **Eremurus** (§ **Henningia**) **Aitchisoni,** *Baker, Journ. Linn. Soc. Bot.* vol. xviii. p. 102. (Plate XXVII. figs. 1–5.)

376. **Allium,** sp. (nov. ?) *A. lineare,* Linn., prox.
Hariáb district, at an altitude of 8000 feet.
The bulbs are like those of *A. strictum*, Schrad.

262. **Trillium Govanianum,** *Wall.*
Malána valley, in birch-forests, at an altitude of from 9000 to 10,000 feet.

227. **Polygonatum multiflorum,** *All.*, var.

Shend-toí, under bushes, at an elevation of from 8000 to 9000 feet.

Juncaceæ.

308. **Juncus lamprocarpus,** *Ehrh.*

In rice-fields and swamps at 4000 feet.

Commelineæ.

490. **Commelina bengalensis,** *Linn.*

Near Alizai.

Glumiferæ.

Cyperaceæ.

494. **Cyperus puncticulatus,** *Vahl.*

Between Shinak and Alizai, in still water.

438. **C. niveus,** *Retz.*

From Thal to Kuram, in hot stony localities; common.

418. **C. Iria,** *Linn.*

Near Kuram, in rice-fields.

493. **C. infraapicalis,** *Nees.*

Alizai, in still water.

307. **Fimbristylis dichotoma,** *Vahl.*

Kuram, in rice-fields.

603. **Scirpus atropurpureus,** *Retz.*

Shálizán, growing with *S. juncoides*, in rice-fields.

420. **S. juncoides,** *Roxb.*

At Shálizán, in rice-fields, at an altitude of 6000 feet.

421,=868 (1879). **Scirpus maritimus,** *Linn.*, var. **macra,** *Boeck. MSS.*

From Thal to Kuram, profuse in rice-fields, up to nearly 7000 feet altitude.

Produces nodules or tubers on its roots.

312, 465. **S. subulatus,** *Vahl.*

From Thal to Kuram, in rice-fields and still water; common.

316. **Eriophorum comosum,** *Wall.*

From Thal to Kuram, growing in great luxuriance from the face of conglomerate cliffs, up to an altitude of 4000 feet.

Collected as fodder for cattle; not employed in the manufacture of twine or rope.

301. **Kobresia schœnoides,** *Boeck.*

Saféd-koh range. On the top and southern exposures of these hills with *K. scirpina*, Willd., forming dense turf above the limit of trees, at from 11,000 to 12,000 feet.

230. **K. scirpina,** *Willd.*

Saféd-koh range, on the tops of the hills, from 11,000 to 12,000 feet, forming turf.

670 (1879). **Carex muricata,** *Linn.*

Shálizán, June.

571 (1879). **C. vulgaris,** *Linn.*

Near Bián-khél, Hariáb district, on moist meadow-land.

313, = 508 (1879). **C. fissirostris,** *Ball in Journ. Bot.* 1875, p. 206; *Journ. Linn. Soc.* xvi. p. 705, *ex Boeckler in litt.*—C. Aitchisoni, *Boeckler in Flora,* 1880, p. 456; *Journ. Linn. Soc.* xviii. p. 105 (nomen tantum). (Plate XXVIII. figs. 1–4.)

1242 (1879). **C. Oliveri,** *Boeck. in Flora,* 1880, p. 455.

Gramineæ.

544. **Panicum antidotale,** *Retz.*

Near Chaprí.

506. **P. maximum,** *Jacq.*, var.? Glumis parce puberulis.

Exact locality not recorded.

531. **P.** (§ **Trichachne**) **pabulare,** *Aitchison & Hemsley*, n. sp. *P. leucophæi* affinis, differt imprimis panicularum ramis divaricatis.

Herba elata, culmis gracilibus, lævibus, glabris, supra vaginam nitidis. *Folia* caulina superiora 6–12 poll. longa, sursum longe attenuata, acutissima, leviter scabrida, basi prope ligulam parcissime barbata; ligula brevissima, lacerata. *Paniculæ* 10–20-ramosæ, pyramidales, ramis divaricatis, infimis fere horizontalibus, usque ad 6 poll. longis. *Spiculæ* geminæ, breviter pedicellatæ, flore mari nullo. *Gluma* exterior minutissima, secunda et tertia subæquales, longe sericeo-pilosæ, secunda 3-nervia, tertia 5-nervia. *Gluma* florifera omnino hyalino-scariosa, 3-nervia, paleam paullo superans. *Ovarium* glabrum.

Between Thal and Chaprí, also on Tór-ghar hill. In great luxuriance in September after heavy rain; considered the best fodder-grass for cattle in these parts.

509. **Panicum sanguinale,** *Linn.*—Digitaria sanguinalis, *Scop.*

From Thal to Badish-khél, very common, covering the low hills.

502. **Pennisetum orientale,** *Pers.*—P. sinaicum, *Decne.*

Thal to Badish-khél, very common.

540. **Lappago racemosa,** *Willd.*
Near Tór-ghar, not very common.

440, 467, =271 (1879). **Saccharum Griffithii,** *Munro, MSS.*
Kuram district, on the arid shingle-plains and borders of fields, up to 6000 feet; common.

546. **S. Sara,** *Roxb.*
From Thal to Kuram, always in the vicinity of water.

532. **Elionurus hirsutus,** *Munro.*
Between Thal and Mandúrí, not very common.

429. **Hemarthria fasciculata,** *Kunth.*
Near Kuram, in rice-fields.

533. **Heteropogon contortus,** *Roem. & Schult.*—H. hirtus, *Pers.*
Between Thal and Mandúrí and on Tór-ghar hill, very common.

6. **Andropogon commutatus,** *Steud.*
On the shingle-plains of Kuram, up to 6000 feet, profuse.

602. **A. laniger,** *Desf.*
On the shingle plains of Kuram, very common.

443. **A. Schœnanthus,** *Linn.*, var.
In the vicinity of Kuram, on the low hills to the south of the river; common.

441, 503. **Chrysopogon ciliolatus,** *Nees.*
From Thal to Mandúrí, and the low hills on the south of the river near Kuram; very common.

19. **Anthistiria anathera,** *Nees.*
On the shingle-plains of Kuram, in profusion.

328, 444, 723, 896, 898 (1879). **Piptatherum,** sp. near *P. holciforme* and *P. molinoides.*
Kuram district and Péwár-kotal, from 6000 to 8000 feet, very common.

278. **Stipa** sp.?
Malána and Zérán valleys and eastwards, from 7000 to 8000 feet altitude.
Collected and employed as bedding at the shrines.

535. **Aristida cærulescens,** *Desf.*
On Tór-ghar hill, near Thal; a common grass.

442, 455. **Aristida cynantha,** *Nees.*

Between Thal and Kuram, and on the low hills to the south of Kuram; common.

1257 (1879). **Melica gracilis,** *Aitchison & Hemsley,* n. sp. Glabra, culmis gracillimis numerosis, foliis angustissimis, spiculis anguste racemoso-paniculatis 3-floris, glumis omnibus glabris.

Herba perennis (?) cæspitosa, fere omnino glabra, culmis numerosis, gracillimis, 1½–2-pedalibus, foliosis. *Folia* caulina plana, angustissima (maxima vix ultra lineam lata), usque ad 6 poll. longa, acuta, vix scabrida; ligula antice longiuscule producta, acuta. *Spiculæ* sæpissime 3-floræ, breviter pedicellatæ, racemosæ, pedicellis infra flores pilosulis; racemi sæpius 4–6-spiculati, in paniculas simplices laxas elongatas dispositi, floribus longiuscule stipitatis, supremo neutro. *Glumæ exteriores* fere omnino scariosæ, obtusæ, dorso obsolete ciliolatæ, inferior 1-nervia, superior 3-nervia. *Gluma florifera* oblonga, obtusa, mutica, integra scariosa, glabra, indistincte 7-nervia. *Palea* lata, scariosa, minute bidentata, gluma paullo brevior, prominenter 2-nervia, nervis leviter scabridis. *Ovarium* glabrum, stylis plumosis.

Kuram district, in the Shend-toí gorge, at 9000 feet, common.

1252 (1879). **Agrostis** (§ **Lachnagrostis**) **Munroana,** *Aitchison & Hemsley,* n. sp. *A. ciliatæ,* Trin., affinis, differt spiculis minoribus, gluma florifera exaristata, etc.

Herba 12–15 poll. alta, fere glabra, culmis gracilibus, foliosis, nodis purpureis. *Folia* radicalia non visa, caulina tenuia, plana, glabra, usque ad 6 poll. longa et fere 2 lineas lata, acuta, utrinque leviter scabrida; ligula lata culmum involvens, circiter 2 lineas longa, truncata. *Spiculæ* circiter lineam longæ, numerosæ, in paniculas angustas strictas dispositæ, pedicellis lævibus, fere filiformibus. *Glumæ exteriores* subæquales, acutæ, inferior dorso minute ciliolata. *Gluma florifera* exaristata, extus intusque pilosa. *Palea* angusta, glabra, gluma paullo brevior.

Kuram district, Shend-toí gorge from 10,000 to 11,000 feet in altitude, common.

1253 (1879). **A. subaristata,** *Aitchison & Hemsley,* n. sp. (Plate XXIX. figs. 1–3.) Species habitu inflorescentia etc. *A. verticillatæ,* a qua differt glumis exterioribus subaristatis, gluma florifera aristata.

Herba 2–3-pedalis, culmis crassiusculis, glabris, lævibus, stoloniferis. *Folia* caulina plana, glabra, supra scabrida, usque ad 4½ poll. longa et 3 lineas lata, acuta; ligula maxima, ochreoidea. *Spiculæ* 2–2½ lineas longæ, anguste denseque paniculatæ, ramulis numerosis, subverticillatis; pedicelli puberuli, spiculis sæpius breviores. *Glumæ exteriores* subæquales, extus undique puberulæ, simul ciliatæ, plus minus aristatæ, aristis terminalibus. *Gluma florifera* glabra, dorso supra medium aristata, arista longiuscule exserta, leviter geniculata. *Palea* glabra, late ovata.

Kuram district, on the margins of fields at 7000 feet; profuse.

648 (1879). **Agrostis verticillata,** *Vill.*, distributed as *Polypogon littoralis,* Sm.

534. **Pappophorum Aucheri,** *Jaub.*
At Tór-ghar, a common grass.

525. **Dactyloctenium ægyptiacum,** *Willd.*
Chaprí to Mandúrí, common.

14, 504. **Chloris villosa,** *Pers.*
From Thal to the shingle-plains of Kuram, up to an altitude of 6000 feet. The commonest and most characteristic grass of the Kuram plains.

510. **Fingerhuthia africana,** *Lehm.*
From Thal to Shinak, on the low hills up to 3000 feet altitude. Extremely common, and one of the chief fodder-grasses of these parts; flowering in August and September, after the usual rains of this period of the year. Previously known only from South Africa.

543. **Phragmites communis,** *Trin.*
From Thal to Kuram, in the vicinity of water; common.

Poa annua, *Linn.*
From Thal throughout the Kuram district, to an altitude of 7000 feet; common.

177,=367 (1879). **Avena** (§ **Crithe**) **oligostachya,** *Munro in Journ. Linn. Soc.* xviii. p. 108 (nomen tantum). (Plate XXX. figs. 1–7.) Species nana, distinctissima, foliis (saltem in siccis) involutis, spiculis sæpissime 4 aggregatis racemosis erectis.

Herba annua, cæspitosa, 9–15 poll. alta, culmis gracilibus, simplicibus, glabris, lævibus, quam folia radicalia sæpius brevioribus. *Folia* radicalia numerosa, conferta, angustissima, in siccis arcte involuta, vix acuta, glabra, subtus lævia, supra scabrida; caulina similia sed multo breviora; ligula angusta circiter 2 lineas longa, apice lacerata. *Spiculæ* sæpius 3-floræ, racemosæ, sæpissime 4 aggregatæ, breviter pedicellatæ, erectæ, cum aristis usque ad 2 poll. longæ, axi in aristam brevem producto. *Glumæ* exteriores leviter inæquales, glabræ, margine apiceque scarioso-membranaceæ, inferior 7-nervis, superior 11-nervis. *Gluma florifera* infra medium longe pilosa, bifida, dorso longe aristata, arista infra medium torta, medio geniculata. *Palea* glabra, bidentata, glumam subæquans. *Ovarium* longe pilosum, stylis elongatis, glumas excedentibus, exsertis.

Kuram district, in the deep gorges that give exit to the various tributaries of the Kuram river, hanging from the cliffs of limestone and slate rocks, at an altitude of from 7000 to 8000 feet; common.

384, =814, 928, 1254, 1255 (1879). **Bromus erectus,** *Linn.*, var.

Hariáb district from Mount Síka-rám to Serátígah, at from 9000 to 13,000 feet altitude ; profuse.

837 (1879). **Agropyrum repens,** *Roem. & Schult.*, distributed as *Lolium perenne,* Linn.

ACOTYLEDONES.

Filices*.

329, 330. **Asplenium Filix-fœmina,** *Bernh.*

Shend-toí valley, in shady woods, at an elevation of from 9000 to 10,000 feet.

454. **Ophioglossum vulgatum,** *Linn.*

Kuram district, on the shingle-plains at an altitude of 5000 feet; August.

Marsileaceæ.

466. **Marsilea quadrifoliata,** *Linn.* ?

From Thal to Shálizán, in rice-fields and still water; very common. Cannot be identified owing to absence of fruit.

Characeæ.

463. **Chara vulgaris,** *Linn.*

Kuram district, at 5000 feet, common in still water and rice-fields.

Fungi †.

Agaricus mitis, *Pers.*

Kuram distriet.

Polyporus pinicola, *Fries.*

Kuram district, on pine trees at an altitude of from 7000 to 8000 feet, very rare.

Geaster minimus, *Chev.*

Hariáb-district, in pine forests at 8000 feet.

G. hygrometricus, *Pers.*

Near Shálizán, in forests at 7500 feet.

* For the identification of the Filices I am indebted to Mr. J. G. Baker, F.R.S.

† For the identification of the Fungi I am indebted to M. C. Cooke, LL.D.

Geaster rufescens, *Fries.*

Hariáb district, Péwár-kotal, in pine-forest at an altitude of from 8000 to 11,000 feet.

Lycoperdon cælatum, *Bull.*

Kuram district, growing from the roots of an old dead tree, at an altitude of 8500 feet.

Appendix.

Since the publication of Part I. of this paper, I have discovered the following errors in the numbers attached to the plants, and take this opportunity to correct them.

Page 33,	line 14	from top,	*for* 77	*read* 377.
„ 34,	„ 8	„ bottom,	„ 621	„ 694.
„ 37,	„ 18	„ top,	„ 433	„ 443.
„ 39,	„ 10	„ bottom,	„ 868	„ 878.
„ 43,	„ 8	„ top,	„ "**M.**"	„ **Medicago.**
„ 51,	„ 13	„ „	„ 387	„ 108, 307.
„ 54,	„ 9	„ bottom,	„ 04	„ 304.
„ 56,	„ 17	„ „	„ 182	„ 782.
„ 57,	„ 19	„ „	„ 413	„ 414.
„ 57,	„ 13	„ „	„ 128	„ 124.
„ 60,	„ 17	„ top,	„ 3	„ 983.
„ 60,	„ 9	„ bottom.	„ 472*a*	„ 427*a*.
„ 61,	„ 6	„ „	„ 873	„ 863.
„ 72,	„ 3	„ „	„ 616	„ 619.
„ 87,	„ 13	„ top,	„ 634	„ 643.
„ 92,	„ 2	„ bottom,	„ 71	„ 671.
„ 93,	„ 13	„ top,	„ 4898	„ 4698.
„ 105,	„ 14	„ bottom,	„ 870	„ 670.
„ 106,	„ 11	„ top,	„ 891	„ 898.
„ 109,	„ 6	„ „	„ 1258	„ 268.
„ 110,	„ 7	„ „	„ 705	„ 709.
„ 111,	„ 3	„ „	„ 71	„ 271.

DESCRIPTION OF PLATES.

The figures of the plants or portions of plants are all of the natural size; and the figures of the analyses are all more or less enlarged.

Plate I.

Map to illustrate the Flora of the Kuram Valley, Afghanistan. The red lines indicate the routes of the two journeys made by Dr. J. E. T. Aitchison;

the blue marks the Kuram River and main tributaries. The diagrams I., II., and III. severally refer to ideal sections running north and south, and partially east and west, as shown by the direction of the arrows in the map.

PLATE II.

Clematis Robertsiana, Aitch. & Hemsl.

Fig. 1. A flowering branch, nat. size. 2. A fertile stamen, enlarged. 3. A slightly metamorphosed stamen, enlarged. 4. A head of achenes, nat. size. 5. A single achene, enlarged.

PLATE III.

Oxygraphis Schaftoana, Aitch. & Hemsl.

Fig. 1. A plant, nat. size. 2. A petal, enlarged. 3. Two stamens, showing back and front of anther, enlarged. 4. An achene, enlarged. 5. An achene with side removed, showing the seed, enlarged.

PLATE IV.

Corydalis pulchella, Aitch. & Hemsl.

Fig. 1. Portion of a plant with most of the leaves removed, nat. size. 2. A sepal, enlarged. 3. A ripe fruit, enlarged.

PLATE V.

Astragalus kuramensis, Baker.

Fig. 1. Portion of plant, nat. size. 2. The standard, enlarged. 3. A keel-petal, enlarged. 4. A wing-petal, enlarged. 5. A fruit, enlarged about one half.

PLATE VI.

Onobrychis dasycephala, Baker.

Fig. 1. Portion of a plant, nat. size. 2. Interior view section of fruit, enlarged.

PLATE VII.

Rosa Beggeriana, Schrenck.

Fig. 1. A branch bearing both flowers and fruit, nat. size. 2. A style, enlarged. 3. A ripe achene, enlarged.

PLATE VIII.

Rosa Ecæ, Aitch.

Fig. 1. Portion of plant in flower, nat. size. 2. The same in fruit, nat. size. 3. An achene, enlarged.

Plate IX.

Gentiana micrantha, Aitch. & Hemsl.

Fig. 1. A plant, nat. size. 2. A corolla laid open, enlarged. 3. Front view of a stamen, enlarged. 4. Back view of a stamen, enlarged. 5. An ovary, enlarged.

Saxifraga afghanica, Aitch. & Hemsl.

Fig. 6. A plant, nat. size. 7. A leaf, enlarged. 8. A calyx, enlarged. 9. Back view of stamen, enlarged. 10. Front view of stamen, enlarged. 11. Fruit, enlarged. 12. A seed, enlarged.

Plate X.

Cotyledon tenuicaulis, Aitch. & Hemsl.

Fig. 1. A plant, nat. size. 2. A flower, enlarged. 3. Back view of a stamen, enlarged. 4. Front view of a stamen, enlarged. 5. A pistil, enlarged.

Sedum pachyclados, Aitch. & Hemsl.

Fig. 6. Portion of a plant, nat. size. 7. Back view of anther, enlarged. 8. Front view of anther, enlarged. 9. A petal with adherent stamen, enlarged. 10. A pistil, enlarged.

Plate XI.

Pimpinella tripartita, Aitch. & Hemsl.

Fig. 1. A plant, nat. size. 2. A petal, enlarged. 3. A pistil, enlarged. 4. A young fruit, enlarged.

Plate XII.

Pleurospermum pulchrum, Aitch. & Hemsl.

Fig. 1. A flowering branch, nat. size. 2. An umbel in fruit, nat. size. 3. A flower, enlarged. 4. A petal, enlarged. 5. A fruit dehiscing, enlarged. 6. A cross section of the same, enlarged. 7. A seed, enlarged.

Plate XIII.

Angelica Strattoniana, Aitch. & Hemsl.

Fig. 1. Portion of root, reduced about two thirds. 2. Portion of a radical leaf, nat. size. 3. A branch in young fruit, nat. size. 4. A petal, enlarged. 5. A carpel, enlarged. 6. A cross section of the same, enlarged. 7. A seed, enlarged.

Plate XIV.

Aitchisonia rosea, Hemsl.

Fig. 1. Portion of plant, nat. size. 2. Inflorescence, slightly enlarged. 3. A corolla laid open, enlarged. 4. An ovary, enlarged. 5. A fruit, the side of the carpels removed to show the insertion of the seed, enlarged.

Plate XV.

Scabiosa (§ *Pterocephalus*) *afghanica*, Aitch. & Hemsl.

Fig. 1. Portion of a plant, nat. size. 2. An involucel, enlarged. 3. A flower, enlarged. 4. A ripe achene, enlarged.

Plate XVI.

Aster lacunarum, Aitch. & Hemsl.

Fig. 1. Plant, nat. size. 2. A ray-flower, enlarged. 3. Style of the same, enlarged. 4. A disk-flower, enlarged. 5. Style of the same, enlarged.

Plate XVII.

Cousinia carthamoides, Aitch. & Hemsl.

Fig. 1. Portion of a plant, nat. size. 2. Bristles of the receptacle, enlarged. 3. A flower, enlarged. 4. An anther, enlarged. 5. Upper portion of style, enlarged. 6. An unripe achene, enlarged. 7. A bristle of the pappus, enlarged.

Plate XVIII.

Cousinia elegans, Aitch. & Hemsl.

Fig. 1. Lower part of a plant without the radical leaves. 2. Upper part of the same, the intermediate part being removed, nat. size. 3. Bristles of the receptacle, enlarged. 4. A flower, enlarged. 5. An anther, enlarged. 6. Upper portion of style, enlarged. 7. A very young achene, enlarged. 8. A bristle of the pappus, enlarged.

Plate XIX.

Pertya Aitchisoni, C. B. Clarke.

Fig. 1. Part of a plant, nat. size. 2. A flower, enlarged. 3. An anther, enlarged. 4. Upper portion of style, enlarged. 5. A bristle of the pappus, enlarged.

Plate XX.

Rhododendron Collettianum, Aitch. & Hemsl.

Fig. 1. A flowering branch, nat. size. 2. Portion of a leaf showing the scurfy indumentum on the under surface, enlarged. 3. A single flower, nat. size. 4. A sepal, enlarged. 5. Upper portion of corolla laid open, showing the hairy throat (rather exaggerated), enlarged. 6. A stamen, enlarged. 7. A pistil with glandular disk, enlarged. 8. A cross section of the same, further enlarged.

Plate XXI.

Rhododendron afghanicum, Aitch. & Hemsl.

Fig. 1. A flowering branch, nat. size. 2. A portion of a leaf showing discoid scales on the under surface, enlarged. 3. A single scale, much enlarged. 4. A corolla, laid open, enlarged. 5. A stamen, enlarged. 6. A pistil with calyx, enlarged. 7. A cross section of pistil, further enlarged.

Plate XXII.

Acantholimon calocephalum, Aitch. & Hemsl.

Fig. 1. Portion of plant, nat. size. 2. A bract, enlarged. 3. Portion of the calyx, enlarged. 4. A petal with a stamen attached, enlarged.

Plate XXIII.

Statice Griffithii, Aitch. & Hemsl.

Fig. 1. Lower portion of a plant, nat. size. 2. Upper portion of the same, nat. size. 3. A one-flowered spikelet, enlarged. 4. A pistil, enlarged.

Plate XXIV.

Arnebia speciosa, Aitch. & Hemsl.

Figs. 1 and 2. Portions of a plant, nat. size. 3. A calyx, enlarged. 4. A corolla, enlarged. 5. A fruit in which two of the nutlets are fertile, enlarged. 6. A fruit in which only one of the nutlets is fertile, enlarged.

Plate XXV.

Veronica rupestris, Aitch. & Hemsl.

Fig. 1. Portion of a plant, nat. size. 2. A corolla laid open, enlarged. 3. Two stamens, showing back and front views of anther. 4. A fruit, enlarged. 5. A seed, enlarged.

PLATE XXVI.

Nannorrhops Ritchieana, Wendl.

Fig. 1. Reduced figure, copied by permission from a drawing of a tree growing in the Botanic Garden, Saharunpore. 2. Portion of young inflorescence, nat. size. 3. A pair of flower-buds, enlarged. 4. Back view of anther, much enlarged. 5. Front view of same. 6. A pistil, enlarged. 7. A vertical section of the same. 8. A young fruit in which all three carpels are growing out, enlarged. 9, 10, 11. Fruits, nat. size. 12. Section of a seed, showing the embryo, nat. size.

PLATE XXVII.

Eremurus Aitchisoni, Baker.

Fig. 1. Lower portion of a plant with most of the leaves removed, nat. size. 2. Upper portion of flower-scape, nat. size. 3. A segment of the outer series of the perianth, with adherent stamen, enlarged. 4. A segment of the inner series of the perianth, with adherent stamen, enlarged. 5. A ripe fruit dehiscing, enlarged.

PLATE XXVIII.

Carex fissirostris, Ball.

Fig. 1. A plant, nat. size. 2. A scale from a female spike, enlarged. 3. A fruit, enlarged. 4. A scale from a male spike, enlarged.

PLATE XXIX.

Agrostis subaristata, Aitch. & Hemsl.

Fig. 1. A plant, nat. size. 2. A spikelet, enlarged. 3. A flowering glume, enlarged

PLATE XXX.

Avena oligostachya, Munro.

Fig. 1. A plant, nat. size. 2. A spikelet, enlarged. 3. The lower glume of a spikelet, enlarged. 4. The upper glume of a spikelet, enlarged. 5. A flower-glume, enlarged. 6. A palea, enlarged. 7. An ovary enlarged.

Note on the Foliation and Ramification of *Buddleia auriculata*.

By Dr. MAXWELL T. MASTERS, F.R.S., F.L.S.

[Read December 1, 1881.]

THE order Loganiaceæ, to which the genus *Buddleia* is now referred (Benth. & Hook. f. Gen. Plant. ii. p. 793), is characterized, among other things, by the presence of opposite or rarely verticillate leaves connected at the base by a narrow transverse line or membrane, or provided at the base with stipule-like auricles, an intrapetiolar sheath, or even with very small true stipules. Such is the statement made in the work above cited. Le Maout and Decaisne, 'Traité général de Botanique,' English edition by Hooker, p. 555, describe the leaves of Loganiaceæ as follows:—"Leaves opposite, stipulate, or exstipulate when the dilated and connate bases of the petioles embrace the stem, with a short, sometimes obsolete border; stipules adnate on both sides to the petioles, or free and interpetiolar, or cohering in a sheath, or axillary, dorsally adnate to the base of the petiole." Lindley, 'Vegetable Kingdom,' p. 602, speaks of the stipules in this order as adhering to the leaf-stalks, or combined in the form of interpetiolary sheaths. Endlicher (Gen. Plant. p. 574) describes the leaves as "opposita, petiolata, ... petiolis basi, nisi stipulæ adsint, in marginem brevissimum amplexicaulem, interdum fere obsoletum combinatis. Stipulæ variæ nunc petiolis utrinque adnatæ, nunc interpetiolares liberæ vel in vaginam coalitæ quandoque axillares dorso petioli basi adnatæ."

It is not necessary to make further citations. Enough has been said to show that, while there is a general agreement of opinion as to the appearances presented, the explanation of those appearances is sufficiently vague. This vagueness, of course, arises from the circumstance that descriptive botanists have been more anxious to discover "characters" than they have been to ascertain their morphological significance. Considering the enormous mass of material to be dealt with, and the often very imperfect means at the disposal of the botanist, this state of things is not to be wondered at. It is nevertheless essential to a natural classification that mere conventional statements, adopted in the first instance from motives of expediency, should, as soon as convenient, be replaced by others more in accordance with the actual

state of knowledge. If, for instance, Robert Brown had bethought himself of the true nature of the so-called stipules in this group, would he have written that "in this genus (*Logania*) the importance of stipulation seems to be entirely lost; for it contains species agreeing in this respect with Rubiaceæ, others in which the stipulæ are lateral and distinct, and one species at least in which they are entirely wanting" * ?

Brown there referred simply to the value of the character for classificatory purposes; and as in this particular group it is inconstant as to presence and variable in appearance when present, the remark was in that connexion justified. On the other hand, if it be true that these organs have distinct morphological significance, and if they furnish a clue to the affinity of the group, then it must be admitted that they are of such importance, that their occasional absence, however much it may detract from their value in an artificial scheme of classification, does not impair their intrinsic value as indications of affinity where they are present. Their presence, we may say, helps us to unravel their genealogy; their absence helps us to forecast the future of their race.

Under the term stipule, as is generally recognized now-a-days, bodies of very varied morphological significance are included. My present purpose is to point out the nature of the so-called stipule or auricle in *Buddleia auriculata* †, and from it to draw certain inferences as to the conformation of sundry of its allies. The plant (for fresh specimens of which I am indebted to Mr. Green, gardener to Sir George Macleay) is provided with two leafy, ear-shaped, reflexed appendages, one on each side of the stem between the bases of the petioles. The true leaves are at first in decussating pairs; but in the lateral shoots, at least, by torsion of the stem, they all come to be placed in one horizontal plane, and are disposed right and left of the axis which bears them, while the auricles just mentioned are antero-posterior, or superior and inferior according to the direction in which the branch is held. If these auricles were really appendages to, or excrescences from, the leaf or from the leaf-stalk, there would be one on each side of the base of each petiole; that is to say, there would be two between each pair of petioles, or four in all. It is

* R. Brown, 'Botany of Terra Australis,' p. 564, ed. Bennett, vol. i. p. 37.

† *Buddleia auriculata*, Benth. in Hook. Comp. Bot. Mag. ii. p. 60, et in DC. Prod. x. (1846) p. 445, "Petiolis basi auriculis rotundatis amplexicaulibus etc."

true they might be united in pairs; and so four such bodies might be so blended as to form in appearance two only.

An examination of the mode of development in the young bud, however, is sufficient to show that no such blending takes place. In the earliest stages there are two leaf-tubercles visible, one on each side of the central axial tubercle. As the leaves grow in length, their basal portions, instead of becoming detached one from the other and from the axis from which they emerge, remain in union for a certain time and to a certain extent, thus forming a leaf-tube surrounding the axis, homologous with the "calyx-tube" or "corolla-tube" of certain flowers. There is thus neither "connation" nor "adnation" in the strict sense of these words, but rather an arrest of development, in consequence of which the separation of parts which should take place does not occur; and they remain congenitally united, or, as I prefer to call it, inseparate. In the first instance, as already said, there are but two leaf-tubercles visible; and in *B. globosa* no more are produced; but in *B. auriculata* the two lateral leaf-tubercles are very quickly followed by two others placed in an antero-posterior direction, and emerging from the margin of the leaf-tube between the bases of the lateral tubercles. The four tubercles thus form a whorl, although they are not simultaneously developed.

It is clear, then, from this that the so-called auricles in this plant represent leaves of a whorl arrested in their development; and this view is supported by a comparison with other species of *Buddleia* and with other Loganiaceæ, wherein every intermediate condition between the mere connecting-line—the base whence the leaves spring, or, rather, appear to spring—and the verticil may be seen*. It is true that the leaves of this verticil are, so far as I have seen, always unequal in size, probably from not being simultaneously developed. The relationship to Rubiaceæ insisted on by many botanists is thus confirmed.

The purport of the suppression or abortion of a portion of the leaves of a whorl may fairly be considered to be to serve as a means of obviating the overshadowing of the leaves below by those above. It is clear that leaves all arranged in the same plane are more fully exposed to the light than those which are placed crosswise in pairs.

* Among the species which either constantly or occasionally show "auricles" similar to those of *B. auriculata* are *B. brachiata*, Cham. et Schlecht., *B. brasiliensis*, Jacq., *B. diffusa*, Ruiz & Pav., *B. longifolia*, *B. verticillata*, H. B. K., *B. crispa*, Benth., *B. salviæfolia*, *B. macrostachya*.

Another peculiarity of *Buddleia auriculata* is its tendency occasionally to produce supraaxillary branches and a plurality of buds in one axil, the uppermost being the oldest and most advanced in development. The position of the first bud or branch above the axil of the leaf is due, not to any fusion of the bud with the axis from which it springs, but to the circumstance that the bud, not becoming detached from the stem, is "uplifted" with it as it grows in length, and hence, after a time, it is found to be at some considerable distance from the axil of the leaf*. The buds formed below this—of which I have seen as many as three in one vertical line, the topmost being the largest—do not in general extend into shoots, although they are capable of doing so under favourable conditions, as I have seen in *Buddleia globosa*. For other instances of multiple buds, the papers of Guillard in the 'Bulletin de la Société de Botanique de France,' vol. iv. (1857), p. 937, and of MM. Bourgeois and Damaskino, in the same publication, vol. v. (1858), p. 598, may be consulted. The latter authors cite *Buddleia* among the genera in which multiple buds occur.

On a Contrivance for Cross-fertilization in *Roscoea purpurea*; with incidental reference to the structure of *Salvia Grahami*. By R. Irwin Lynch, A.L.S., Curator of the Botanic Garden, Cambridge.

[Read November 17, 1881.]

I have the pleasure of describing to the Society an interesting form of floral mechanism by which cross-fertilization is secured in *Roscoea purpurea*, one of the Zingiberaceæ. It is more particularly interesting when compared with the well-known mechanism of *Salvia*. In both cases the pollen is brought into contact with an insect entering the flower by means of levers which are specialized from the anther part of the stamen, and in both cases the filament forms the fulcrum. So far, the action is similar; and to this extent the comparison seems of interest on account of showing a similarity of apparatus in plants so far from being related as are *Roscoea* and *Salvia*. No further comparison can be made, however, on account of widely different structure. The

* A similar upraising of the bud and consequent supraaxillary ramification is seen, constantly or occasionally, in *Buddleia curviflora, B. asiatica, B. macrostachya*, the inflorescence of *B. Colvillei*: see Hook. f., Ill. Him. Pl. t. 18.

structure of *Roscoea* I may be better able to describe with the help of the diagram. The flower has one stamen; the anther is seated on a stout filament, and is provided with two spurs which project over the tube of the flower The style is extremely slender and flexible every way; it comes up the tube, passes between the spurs, then runs between the anther-cells, and produces the stigma at the top of the anther. It must be observed that the anther swings on its filament when the spurs are touched. The result of this structure is, that an insect coming into the flower depresses these spurs, and this action necessarily brings the anther and stigma to the position I have here marked B in figure. While in this position the stigma takes up pollen from the insect which has come from another flower; and the insect also receives a further supply of pollen from the anther over its back. I have referred to *Salvia*; and should now point out that *Roscoea* differs in bringing down by its lever action, not only the anther, but also the stigma; while in *Salvia* there is no connexion between them, and the style either remains stationary, or is moved by another and distinct impulse. In *Salvia* there are two fertile stamens, and of each the anther-connectives unite to form one lever which swings between the two filaments; its structure, however, being well known, it is hardly within my province to recapitulate. The anthers differ greatly in structure; but there is the lever-process in *Salvia* which nearly corresponds with the lever-process of *Roscoea*.

Diagram flower of *Roscoea purpurea*. **A**, with anther and pistil in natural position; and B, with dotted outline as bent on an insect entering.

The attention of the Fellows at the Meeting is directed to a drawing of *Roscoea*, from a specimen in the Cambridge Botanic Garden which flowered during the past summer; and a flower in spirit is also exhibited, which elucidates the structures now under consideration.

There is one remark I should like to make with regard to this *Salvia*, which differs from most other species. If not typical *S. Grahami*, it is a slight variety. The flower is quite closed, and seems to form a trap. The only way in is by pressing back the anther-connectives, which form a valve over the entrance. Any insect getting behind is prevented from returning the same way.

In trying to escape, it naturally goes up an incline over the valve, and so reaches the fertile anther-cells, when it gets covered with pollen, and presently escapes by pushing open the upper lip, which is folded over itself so as to form a chamber. The special conformation of this species seems to demand explanation; and as an important end could be attained in the way I have suggested, I venture to submit that it may be the right explanation. This species seems adapted for small insects which could never be touched with pollen in the usual way; but being forced to pass through the anther-chamber, if I may so term it, they get well dusted.

On a Hampshire Orchis not represented in 'English Botany.'

By C. B. Clarke, M.A., F.L.S.

[Read November 17, 1881.]

(Plate XXXI.)

The Orchis is plentiful in the marshes of the River Test, and is allied to *O. latifolia*, Linn.

O. latifolia, Linn., is abundant in the same marshes: it is figured in Sowerby; and the same plate is repeated by Syme, the name being altered to *O. incarnata*; but it does not represent *O. incarnata*, Linn. *O. latifolia*, Linn., is well depicted in Sowerby's plate: the leaves are a heavy green, not rarely spotted; the spike is somewhat lax, often broader at the base; many of the bracts are longer than the flowers; the flowers are reddish purple, varying thence to white; there is no yellow. The North-British form of *O. latifolia* sometimes contains some yellow.

The Hampshire Orchis (Plate XXXI.) has pale green leaves never spotted; the spike is cylindric, dense with strict flowers; few of the bracts are longer than the flowers; the flowers are a pale flesh-colour with yellowish lip, fading to a sallow yellow; the margin of the lip has a line sometimes bright rose when young; but the flowers have at no period any purple about them. This Orchid I described in my 'List of Andover Plants,' published in 1866, as *O. incarnata*, Linn., var. I have lately looked through the Herbaria of Lindley, Borrer, and Watson without

finding my plant. But in looking through the Kew Herbarium, I saw at a glance that the example of *O. incarnata*, Linn., in Fries's standard distributed herbarium was my plant. This was collected by Afzelius at the identical spot where Linnæus first collected his *O. incarnata*; and is marked by Fries "*O. incarnata*, Linn., certiss.!" I next looked up the herbarium of Linnæus; his specimen of *O. incarnata* is one spike only, but is the same thing.

The original description of Linnæus of his *O. incarnata* in the 'Fl. Svecica,' ed. 2, p. 312, runs:—

"n. 802. Orchis incarnata; bulbis palmatis, nectarii cornu conico, labio obscure trilobo serrato, petalis dorsalibus reflexis.

"Orchis palmata lutea, floris labio maculato. Segv. Veron. 3. p. 249, t. 8. fig. 5.

"Præcedenti" (i. e. *O. latifoliæ*) "simillima; a quâ differt: foliis pallide viridibus immaculatis; nec saturate viridibus maculatis. Caule dimidio breviore. Bracteis vix flore aut germine longioribus. Corollis pallide incarnatis, nec rubris. Petalis 2 dorsalibus totaliter reflexis; nec tantum patulis nec maculatis. Nectarii labium structura convenit."

As Linnæus says that his Orchis had flowers a pale flesh-colour, without any red, and further identifies it (perhaps wrongly) with a yellow-flowered Orchis, and finally named it, on account of its extraordinary colour, *O. incarnata*, it is difficult to understand how it could have been supposed to be the *O. latifolia* of Smith and Sowerby, essentially a purple-red Orchis. The minor points mentioned by Linnæus all support the view that Afzelius and Fries have got the veritable plant of Linnæus. The lip is narrower than in *O. latifolia*, and the lateral lobes are in the living plant very strongly reflexed; the central lobe is longer than the lateral.

Whatever view be held concerning the identification of the Hampshire Orchis with the true *O. incarnata*, Linn., I do not think, with Syme and Sowerby open before us, it can be maintained that any figure hitherto published represents it.

[I have found examples of this species in the herbarium of Mr. Nicholson from Cornwall. Mr. Newbould tells me that he once saw it at Ringwood. Mr. Ridley tells me that it is well known to Winchester schoolboys, from whom he has received it, collected in the New Forest. At the Meeting of the Linnean Society on 17th November, 1881, Mr. Crombie said he formerly

collected it near Brockenhurst. It was also said (doubtless correctly) to be abundant near Romsey, and to be known in Cornwall.

The Hampshire and Cornish are therefore the only stations at present known in England.]

DESCRIPTION OF PLATE XXXI.

Orchis incarnata, Linn.

Fig. 1. Plant, of natural size.

2. Front view of flower, enlarged; the colour, shown here from a flower just expanded, soon fades away to a sallow or yellowish fish-colour.

3. Side view of flower, enlarged.

Note on *Abies Pattonii*, Jeffrey MSS., 1851. By W. R. M'Nab, M.D., F.L.S., Professor of Botany, Roy. Coll. of Science, Dublin, and Scientific Superintendent of the Royal Botanic Garden, Glasnevin.

[Read December 15, 1881.]

The plants known in cultivation under the names of *Abies Hookeriana* and *Abies Pattoniana* have long been a source of great confusion and perplexity both to botanists and horticulturists; and the conflicting opinions of authors find expression in the most marked way in the recent 'Manual of Coniferæ,' published by Messrs. Veitch, where in page 117 of that work it is stated that "there are two horticulturally distinct forms in cultivation," although "botanically the two trees are considered to be but one species."

The two forms have been in cultivation in the Royal Botanic Garden, Edinburgh, since their first introduction; and, with the aid of a copious series of specimens, chiefly supplied by my late father, Mr. James M'Nab, and raised from seed by himself in the Edinburgh Garden, I believe I am in a position to give a corrected history of the two forms. That the forms are distinct microscopically, I have already pointed out in my paper in the 'Proceedings of the Royal Irish Academy,' vol. ii. 1875, p. 209, and have given figures of the sections of the leaves. Although the leaves of both have been examined, I have only succeeded in getting the cone of one of the forms. In the paper just referred to I stated that the cones of the two were exceedingly close; but

recent examination shows that these cones were all of one species. The specimens in the museum and herbarium of the Edinburgh Royal Botanic Garden have been examined; and through the kindness of Professor Balfour, F.R.S., I was permitted to obtain a set of type cones as well as a series of leaves for microscopical examination. In no case have I been able to obtain a cone of *Abies Pattonii*, Jeffrey MSS., all the cones examined belonging to one species, the plant known as *Abies Hookeriana* in the Royal Botanic Garden, Edinburgh.

In 1851 Mr. John Jeffrey, the collector of the Oregon Association, sent home seeds of a Pine with the following description:—"Found on the Mount-Baker range of mountains. This species makes its appearance at the point where *A. canadensis* * disappears, that is, at an elevation of about 5000 feet above the sea; from that point to the margin of perpetual snow it is found. Along the lower part of the range it is a noble-looking tree, rising to the height of 150 feet, 13½ feet in diameter. As it ascends the mountain it gets gradually smaller, till at last it dwindles into a shrub not more than 4 feet high.

"Leaves solitary, dark green above, silvery beneath, flat and rounded at the points, thickly placed round the branches; cones about an inch long, produced at the points of the branches, pendulous; bark rough, of a greyish colour; timber hard and very fine in the grain, of a reddish colour. Soil in which this tree was growing most luxuriant was red loam, very strong and moist. If this tree proves undescribed, I hope it may be known under the name of *Abies Pattonii*."

Seedlings of this were raised in the Edinburgh Botanic Garden; and there is now one good plant living in the Garden; but I have not been able to find any dried specimens or cones in the museum or herbarium. Jeffrey's description of the leaf is so exact, that the plant intended by him cannot be mistaken. In the next consignment of seeds from Jeffrey we have his no. 430, "Cascade Mountains, lat. 42°. Elevation 6000 feet. October 15, 1852." And Jeffrey adds (see Murray, 'Synonymy of various Conifers,' p. 15):—"I forwarded specimens of this species in case no. 3, and at the same time suggested that it should be named *A. Pattoniana*." Numerous specimens are extant of Jeffrey's no. 430; and all I have examined are, without exception, the species described by Murray as *Abies Hookeriana*. The Oregon

* Probably *A. Albertiana*, A. Murr.

Committee seems to have accepted Jeffrey's determination without examination*, and printed the description of the Mount-Baker tree from lat. 44° N., and sent it out with the seeds of no. 430 from lat. 42° N. My late father was cognizant of this; and in his paper in the Transactions of the Bot. Soc. Edin. vol. xi. p. 327, says, "*Abies Hookeriana* was sent by Jeffrey at the same time" as *Abies Pattoniana.* The examination of the structure of the leaves and of the cones of Jeffrey's no. 430 demonstrates that the plant is that afterwards figured and described by Murray as *A. Hookeriana.* The confusion of the plants thus originates with Jeffrey himself. Professor Balfour's description of *A. Pattoniana* was printed in 1853 in the Circular of the Oregon Committee, for the private use of the Members of the Association; and the specimens described are evidently Jeffrey's no. 430, and not the plant of 1851 from Mount-Baker.

In 1854 Mr. William Murray discovered a Pine on Scot's Mountain, lat. 41° 20′ N., which was described in 1855 by Mr. Andrew Murray in the 'Edinburgh New Philosophical Journal' (April 1855) as *Abies Hookeriana.* Cones of Murray's plant in the museum of the Edinburgh Garden are the same as those of *Pattoniana*, Balfour, in the same collection; and although Murray gives different figures of the bract of the two forms, I have not been able to find any cone with the bract corresponding to his figure of what he calls *A. Pattoniana*, Balfour. Moreover, Murray does not state whether the bract figured is from a Mount-Baker or Cascade-Mountain specimen, a most important omission. We are now prepared to find Carrière, Parlatore, and others uniting the two supposed forms described by Balfour and Murray, as they are simply one and the same thing.

In 1863 Mr. Andrew Murray, in his 'Synonymy of various Conifers,' p. 14, pointed out that the leaves of Jeffrey's Mount-Baker plant and those of *A. Hookeriana* from Scot's Mountain were quite different, a character on which my late father always insisted. The leaf of *A. Pattoniana* is flat and serrate at the tip, while that of *A. Hookeriana* is entire and more quadrangular, Murray's figures 16 and 17 showing the difference admirably. The plants are here for the first time properly separated, by characters derived from the leaves only, the cone of Jeffrey's Mount-Baker plant never having been figured.

Parlatore, in DeCandolle's 'Prodromus,' evidently combines

* Murray, *loc. cit.* p. 15.

the two forms, notwithstanding Murray's figures of the leaves both in the 'Synonymy' and also in the 'Pinetum Britannicum,' part iv., as he says (Prod. xvi. p. 429) that the leaves are "ad margines lævibus vel apicem versus serrulatis." Dr. Engelmann's *A. Pattoniana*, to judge from the figure in Veitch's 'Manual of the Coniferæ,' p. 116, is Murray's *A. Hookeriana*, although given as distinct in that work.

The coloured plate with the two supposed species represented in Lawson's 'Pinetum Britannicum' requires some remarks. There can be little doubt that the figure of *A. Hookeriana* would be drawn from authentic specimens in Mr. Murray's collection; but in the absence of any statement regarding the source of the supposed specimen of *A. Pattoniana*, I would suggest as probable that the foliage is from a fresh specimen from the Royal Botanic Garden, Edinburgh, of Jeffrey's Mount-Baker plant, while the cones were added from museum specimens of Jeffrey's no. 430. As Jeffrey says the cones are "about an inch long, produced at the points of the branches, pendulous" (see above), it is obvious that some error has crept in.

Assuming that there are two forms, the question of names will turn entirely on the value to be assigned to Balfour's name and description in the Oregon Circular of 1853. If *A. Pattoniana*, Balfour, stands, *A. Hookeriana*, Murray, sinks; and Jeffrey's Mount-Baker plant is an unnamed species, which might well bear the name of *Tsuga Balfouriana*. But I think we must hold that Balfour's name and description were unpublished, the Circular of the Oregon Committee being an unpublished document, for private circulation; and we get a species correctly described, as regards the cone, by Mr. Andrew Murray in 1855 as *A. Hookeriana*, and further in 1863 as regards the leaf. This is Jeffrey's no. 430, and Mr. William Murray's Scot's-Mountain plant, as well as *A. Pattoniana* of Balfour and Jeffrey's *A. Pattoniana* in part. *Abies Pattonii*, Jeffrey MSS., 1851, is described correctly as regards the leaf by Mr. Murray in 1863; but up to the present the cone has never been described, except imperfectly by Jeffrey himself. The chief points in the very complex synonymy may thus be expressed for the two forms:—

1. Tsuga Hookeriana.—*Jeffrey* no. 430. Cascade Mountains, lat. 42° N. Abies Pattoniana, *Balfour, Oregon Circular*, 1853 (unpublished).

Abies Hookeriana, *Murray, Ed. N. Phil. Journal,* April 1855 (cone), and *Syn. of various Conifers,* 1863 (leaf); *Pinetum Britannicum,* pt. iv. figs. 9, 12, & 13.
Abies Pattonii, *Gordon, Pinetum,* 1858.
Abies Williamsonii, *Newberry,* 1857 (*non hort.*).
Tsuga Pattoniana, *Engelmann.*
Pinus (§Tsuga) Hookeriana, *M'Nab, Proc. R. I. Acad.* 1875.

2. Tsuga Pattoniana,—Abies Pattonii, *Jeffrey MSS.* 1851. From Mount-Baker.
Abies Pattoniana, *A. Murray,* 1863 (leaf).
Pinus (§Tsuga) Pattoniana, *M'Nab, Proc. R. I. Acad.* 1875, leaf (*non Parlatore*).
Abies Parryana, *Hort. Edin.* (leaf).
Abies Hanburyana, *Hort. Edin.* (leaf).

It is greatly to be desired that cones of the Mount-Baker tree be obtained, as our knowledge of *Tsuga Pattoniana* from the leaf only is very unsatisfactory; and we trust that American botanists may soon find cones which will answer to Jeffrey's description.

On a new Species of *Gossypium* from East Tropical Africa. By Dr. Maxwell T. Masters, F.R.S., F.L.S.

[Read December 15, 1881.]

The discovery of any species of Cotton in a truly wild condition is a matter of very considerable interest historically, and in relation to the probable origin of the very numerous cultivated varieties*.

Excluding plants which have probably escaped from cultivation, or which have descended from cultivated species, we now know with greater or less probability of the existence of wild species of *Gossypium* in Asia, Africa, Oceania, and Australia, thus:—In Sindh, *G. Stocksii,* Mast., occurs, which is probably the prototype of the cultivated Indian varieties referred to *G. herbaceum.* In Oceania two species are considered wild—*G. sandvicense,* Parl., and *G. taitense,* Parl. In Australia the very distinct *G. Sturtii* occurs, which, however, perhaps is not a true *Gossypium.* In tropical Africa, *e. g.* in Nubia, Angola, and Benguela, *G. ano-*

* For a *résumé* of what was known on this subject up to the date of publication, see Alphonse de Candolle, 'Géographie Botanique,' t. ii. p. 973.

malum has been found; and this was considered by the late Dr. Welwitsch, whose opinion on such a point carries the greatest weight, to be the only form truly wild in Africa. To these must now be added the species found in the Zanguebar district, and which has suggested the present note.

It is worthy of remark that in all the plants just mentioned the cotton is short, and of a yellowish or nankeen colour.

Gossypium Kirkii, the technical characters of which are appended to this communication, was found by Dr. (now Sir) John Kirk at Dar Salam.

In a letter with which he has favoured me, Sir John says that he has always regarded it as the nearest thing to the cotton of cultivation, and that he never saw it except in one locality, where it grows on a slope, and where it scrambles up between and over the bushes and trees to a height sometimes of 14 feet, but generally less. "To judge from appearances," continues Sir John, "it is quite wild, and has no near relation to any cultivated plant."

To me the present plant seems more nearly allied to *G. barbadense* than to any other species. It may here be remarked that *G. barbadense*, in some or other of its varieties, is the species most commonly grown in tropical Africa, one variety, *G. barbadense* var. *acuminatum*, which yields the Kidney Cotton, having been found in cultivation by the Makonde people eighty miles from the coast. Sir John Kirk also found the plant cultivated near Lake Nyassa, and along the Zambesi, Shiré, and Rovuma valleys. Cameron met with it cultivated near Lake Tanganyika; and Speke and Grant in lat. 7° 27′ S., long. 37° 30′ E. In the north Vogel found it cultivated near Lake Tsad; it is grown in Abyssinia; and there are specimens in the Kew Herbarium from the Somali coast. On the western side of the continent, *G. barbadense* is the species principally cultivated from Senegal to Angola, and in the islands, as in Madeira, Canaries, Fernando Po, &c. In Madagascar, also, *G. barbadense* is the form usually grown. This species may therefore be taken as the prevailing one in tropical Africa generally. Along the Nile valley, however, *G. herbaceum* is the form most commonly grown, extending as far as Khartum; and occurring in a naturalized or half-wild condition along the White Nile, lat. 9° 15′ N., where it was found by Dr. Murie. Specimens are in the Kew Herbarium from this locality, labelled "Not cultivated—introduced."

According to the best authorities, Cotton was not cultivated in Egypt in ancient times; and the fact that the varieties now grown there are, for the most part, forms of *G. herbaceum*, suggests the idea that India is the source whence Egypt has derived the Cotton, a notion confirmed, I believe, by various other considerations not of a botanical nature.

The following are the technical characters of the new species, for an opportunity of examining which I am indebted to my friend Prof. Oliver :—

Gossypium Kirkii, *Mast.*, sp. n.

Suffruticosum, subscandens (*Kirk*), pubescens; petiolis divaricatis subangulatis quam laminæ longioribus, foliis superne stellato-pilosis subtus velutinis glandulis nigris præditis, ambitu late ovatis acutis, basi cordatis palmatim 5-lobis, lobis ovato-lanceolatis acuminatis, nervo medio excurrente, lobo mediano longiore; stipulis falcato-acuminatis; pedunculis petiolos superantibus supra medium articulatis; bracteis magnis cordato-suborbicularibus margine anguste et argute laciniatis; calyce cupulato obscure 5-dentato intus ad basin piloso; corolla luteo-oculata?; capsula bracteis multo minore, 8–9 mm. long. oblongo-conica scrobiculata; seminibus liberis nigris lineis pilosis longitudinalibus 2–3 notatis, lanaque gossypina brevi fusco-rubra separabili indutis.—Dar Salam, in Africa tropicali meridionali-orientali, ubi detexit feram cl. Kirk.

Note on a Proliferous Mignonette.

By the Rev. George Henslow, M.A., F.L.S., F.G.S.

[Read December 1, 1881.]

(Plate XXXII.)

The plant from which a "strain" has been already established *, and is the subject of this note, appeared accidentally amongst some seedlings in the nursery of Mr. W. Balchin of Hassock's Gate. A basketful obtained by cuttings was exhibited at the Royal Horticultural Society in the spring of this year (1881). At that time it much resembled the ordinary kind, only the flowers were double, forming little balls of minutely fringed petals. In August Mr. Balchin kindly forwarded me some sprays

* *Reseda odorata*, var. *prolifera alba.*

which exhibited a much greater development, and from one of which Plate XXXII. was drawn.

The large panicles into which the spikes have now developed are more than a foot in length, branching profusely to within a few inches of the apex, with elegantly depressed branches having their apices ascending. The whole is covered with double and richly scented flowers.

The proliferous character of the specimen is seen in the fact that every branch arises out of the centre of an abortive flower, and occupies the place of the pistil. Occasionally two branches arise out of the same flower. In some cases a whorl of open, but coherent carpels is seen, showing that the branch originates from the middle of that whorl (see fig. 2, *Pi*).

Each of the branches, especially the lower, may have lateral ones. These also in the same way rise out of the centres of similarly proliferous flowers.

The plant cannot set seed, but has been readily propagated by cuttings. It is a handsome variety, totally unlike any of the finest of the ordinary kinds of Mignonette, and has a rich perfume resembling apricots, or, as some think, that of peaches.

A monstrous form of Mignonette was described and figured by the late Prof. J. S. Henslow in a paper read before the Cambridge Philosophical Society in 1832, and published in the Transactions. In that case the axis of the flower was elongated, but bore a malformed ovary at the extremity, while the disk disappeared. The tendency of the flower, however, was to be foliaceous; the petals, stamens, carpels, and ovules assuming a more or less green and leaf-like character. Hence it in no way resembled the double form herein described*.

Another instance was met with last autumn (1881), in which the calyx was normal, the corolla, stamens, and pistil *absent*. In their stead was a prolonged axis, bearing below numerous, scattered, more or less petaloid scales, and, above, a raceme of flowers. Each of the secondary flowers had a calyx and corolla, as usual, or an increased number of sepals and petals, but no stamens. In the centre was a stipitate ovary with imperfect ovules.

It is to be observed that when the axis of the flower elongates in the above monstrous states, the disk either vanishes altogether, or else assumes a regular form as a thickened ring or cylinder about the axis, instead of being unilateral as in normal flowers.

* See also Schimper, Bot. Zeit. ser. 1 (1829), p. 428.

DESCRIPTION OF PLATE XXXII.

Fig. 1. Spray of *Reseda odorata*, var. *prolifera alba*.

Fig. 2. Isolated branch proceeding from the centre of a calyx (*ca*), from which the corolla has probably fallen. Above it is a rudimentary pistil (*Pi*), the axis of which is prolonged into a flowering branch, from which secondary branches have proceeded in a similar way. The flowers which have retained their corollas consist of spherical tufts of fringed petals.

Fig. 3. An instance where two branches have proceeded out of one and the same calyx.

Fig. 4. A flower with the corolla removed, to show the columnar disk (instead of being unilateral, as in normal flowers) which bore the supernumerary petals which replaced the stamens. In the centre proceeds an abortive ovary of several open, but coherent carpels.

Fig. 5. Ovary of fig. 4 opened, to show the rudimentary bud within it.

Fig. 6. Petal with nine lobes. (The usual number is from nine to twelve.)

Fig. 7. Petal with only one lobe.

Note on Staminiferous Corollas of *Digitalis purpurea* and *Solanum tuberosum*. By the Rev. GEORGE HENSLOW, M.A., F.L.S., F.G.S.

[Read January 19, 1882.]

(PLATE XXXIII.)

THE subject of the present note was forwarded to me by the kindness of Mr. R. Mullard of Bermondsey, and consisted of a fine stem of *Digitalis purpurea* laden with blossoms, but which were very abnormal in having the corollas laciniated and staminiferous. He informs me that "the specimen was gathered at Tilburston Hill, Surrey; and there were four flower-stalks growing apparently from distinct roots. On neither of the four stalks was there a normal flower. The corolla of most of the flowers on one stalk was reduced to a thread, and that often had a rudimentary anther, while some had two. Some of the filaments had as many as four anthers; and some of the flowers seven stamens." He also adds:—"I notice that the posterior stamens remain under the lip, as in the normal flower, while the anterior ones are reflected back in a direction at right angles to the posterior. The stigma also projects much further beyond the posterior anthers than in the normal flowers. The consequence is, that the anterior stamens are overtopped by the flowers above in such a way that the stigma

comes into contact with the reflected stamens of the flower below."

In the drawing I have made of the upper part of the raceme, it will be seen how the flowers hang nearly vertically, instead of being oblique in their position as in the normal form; while the tube is deeply laciniated, forming a fringe or ribbon-like strips, some of which are antheriferous, others not. The four proper stamens of the flower can be recognized by the usual bend at the base of the filament, but assume a nearly horizontal position.

The calyx and pistil remain of the normal character.

Staminody of the corolla is far from being common amongst plants. Dr. Masters records only about a dozen instances as known, in his work on Vegetable Teratology, amongst which he says, " Moquin cites from Chamisso *Digitalis purpurea* as having presented this change"*.

Staminody of the petals of the Potato has been twice recorded. A specimen before me was forwarded to Dr. M. T. Masters in 1870, by Mr. Marshall, of Ely, who briefly described it with a figure in 'The Gardeners' Chronicle' (1870), p. 1021. I have adjoined a few details (Plate XXXIII. figs. 7–11) not given by that botanist, to show the nature of the staminiferous petals. On a careful examination of the dried flower, I find the calyx to be normal. The corolla is gamopetalous, there being a short tube; but the lobes are more or less perfectly antheriferous. Figs. 9, 10, 11 will show how the lobes have assumed a cochlear form with the edges thickened, and more or less converted into anthers. In some only, as in fig. 9, was there pollen; but, judging from the appearance in the dried state, the grains were apparently abortive.

The entire flower presented the appearance as shown by fig. 7.

The stamens were normal in form, and occupied the usual position upon the coherent tube of the corolla, dehiscing as usual by a terminal pore with a longitudinal slit below (fig. 8). Excepting fig. 7, which is the natural size, the rest (figs. 8–11) are enlarged.

It has been suggested that there is some reason for thinking that a race of potatoes of the kind herein described might be

* Clos, 'Tératologie taxinomique,' p. 28, records:—"*Digitalis purpurea* a les pétales remplacées par les étamines." Possibly Moquin refers to this.

formed by the continued propagation by tubers, as in various places large breadths have been seen, the flowers of the potatoes being all similarly affected.

DESCRIPTION OF PLATE XXXIII.

Sketches from nature, illustrating the malformation in *Digitalis purpurea*.

Fig. 1. Terminal portion of the inflorescence.
2. Anterior side of a corolla, with stamens.
3. Posterior side of the same.
4. Lateral view of the same.
5. Entire flower, shown on its posterior side.
6. The same, viewed laterally.

Sketches showing malformation in the Potato.

7. Flower of Potato, with staminiferous corolla.
8. Normal stamen of same.
9, 10, and 11. Staminiferous lobes of the corolla.

On the Connection between Geotropism and Growth.

By FRANCIS DARWIN, M.B., F.L.S.

[Read April 6, 1882.]

IF the *punctum vegetationis* is removed from a root * by cutting off about 1·5 millim. by a transverse section, the root loses its power of bending geotropically, although it continues growing vigorously. This curious experiment was first made by Ciesielski †, and has been confirmed by my father and myself in a large number of observations ‡. Ciesielski made the further observation, that if a root be placed horizontally for a short time before the tip is cut off, the geotropic curvature will take place in spite of the operation. It must be understood that no curvature takes place during the period which elapses before the operation; consequently the fact of the curvature taking place afterwards, shows that the operation does not interfere with the act of curvature. These experiments we have also confirmed in various ways.

It would be possible to draw two distinct conclusions from these experiments:—(1) It may be supposed that the operation of cutting off the tip acts as a shock, and so disturbs the organi-

* *E. g.* of *Vicia faba*, Pea, or *Phaseolus*.
† 'Abwärtskrümmung der Wurzel.' Inaug Dissert., Breslau, 1871.
‡ 'The Power of Movement in Plants,' ch. xi.

zation of the root, that it is incapable of reacting to the stimulus of gravitation in the proper manner. Or (2) it may be supposed that it is not the effect of the operation *per se*, but the loss of the *punctum vegetationis* which produces the effect. These two points of view may be made clearer by an example: an animal may be prevented from performing a normal movement either by a severe operation which disturbs its organization, or by the loss of an organ which is necessary to the performance of the movement. A man's movements may be rendered irregular either by a general shock, or by blinding him. A limb may be rendered useless either by a violent blow or by cutting the nerve.

We hold the second of the above theories; and believe that the *punctum* is the part of the root on which the force of gravity acts, and that an influence is thence transmitted to the part of the root which bends. According to this view, when a root is placed horizontally for some time before the tip is removed, the stimulus is transmitted to the bending-place, and the loss of the tip could not therefore be expected to prevent the geotropic curvature taking place.

This view has recently been criticized by Wiesner*. He believes, in the first place, that the hindrance to geotropism is not so well marked as we supposed; and, secondly, that any effect produced is explained by the fact that roots whose tips have been removed do not grow so quickly as normal roots. It is a well-known fact that any thing which interferes with growth interferes with geotropism. Sachs has shown that roots cultivated in damp air grow less vigorously, and are less geotropically sensitive than those cultivated in damp earth†. Thus Wiesner's view appears to be in accordance with known facts. But Wiesner does not give sufficient weight to the experiment in which the root is subjected to the stimulus of gravitation before the operation; and this observation can only be brought into accordance with his view by supposing that the operation has different effects on the receptivity to stimulation and on the completion of the resulting curvature. It may be noted, in passing, that this would not agree with Wiesner's views as to the action of other stimuli on plants; for he takes pains to show ‡ that the conditions

* 'Das Bewegungsvermögen der Pflanzen,' 1881, p. 97.

† 'Arbeiten,' i. p. 447. Sachs is careful to add that this difference in geotropism is not connected with the difference in growth.

‡ Monograph on "Die heliotropischen Erscheinungen," pt. 1, p. 68.

necessary for the "induction" of a heliotropic curvature are the same as those necessary for the completion of the curvature.

In the following abstract of some of Wiesner's results the figures given are the average increase in length *per cent.* in 24 hours of four normal and four "cut" roots (*i. e.* those whose tips have been cut off).

Maize.

Normal.	Cut.
77·5	41, or as 100 to 53·9.

Peas.

42·7	9·7, or as 100 to 22·7.

Vicia Faba.

90	60, or as 100 to 66·7.

In repeating Wiesner's experiments, I have thought it best to take shorter periods of growth, since geotropic curvatures are generally completed long before 24 hours have elapsed.

Experiment I., Jan. 17, 1882.—Six roots of *Vicia Faba,* from 2–3 centim. in length, were marked at 8 millim. and again at 11 millim. from the tip; 1·5 millim. was then cut off three of them, and the length of about 3 millim. between the two marks was measured with a weak objective and eyepiece-micrometer. The eyepiece was divided into large spaces each equivalent to ·375 millim.; and by estimating the $\frac{1}{10}$ths, the rate of growth could be expressed in units equivalent to ·0375 millim. When the roots became too much curved to be thus measured, the growth was taken with a pair of compasses and a millimeter-scale. During the experiment the roots were placed horizontally on damp peat in a small tin box.

Cut Roots.*

	Original lengths. millim.	Percentage growth in 1 h. 50 m.	Percentage growth in 2 h. 20 m. additional.
i.	2·5	6	17
ii.	2·6	4	11
iii.	2·0	4	14
	Average...	4·7	14

* The roots whose tips had been amputated are called "cut" roots. "Percentage growth" during a given period is obtained by reducing to 100 the length of the measured portion at the beginning of that period.

Normal Roots.

	Original lengths. millim.	Percentage growth in 1 h. 50 m.	Percentage growth in 2 h. 20 m. additional.
i.	3·0	8	5
ii.	2·7	7	5
iii.	2·8	8	13
	Average...	7·7	7·7

If we compare the rates of growth during the first period, we have :—

Normal roots 7·7, cut 4·7 ; or as 100 to 61.

For the second period we have :—

Normal roots 7·7, cut 14 ; or as 100 to 182.

If we take the growth during the whole period, we have the averages :—

Normal roots 16, cut 19·7 ; or as 100 to 123.

This experiment is unsatisfactory in one way, because the measured space was taken too far from the apex of the root. Moreover, for some reason not even the uninjured roots became properly geotropic. Nevertheless the experiment shows that the effect of the operation lasts only a short time, and that as the "cut" roots recover, they may actually grow more quickly than the normal ones.

Experiment II.—In this case the roots were marked at (roughly) 2 millim. and 5 millim. from the apex ; so that the measured space of about 3 millim. was nearer the apex than in the former experiment. Otherwise the conditions were as before.

Cut Roots.

	Length of measured space. millim.	Percentage growth in 4 h. 43 m.	Percentage growth after 2 h. 12 m. additional.	Percentage growth during 12 h. 10 m. from beginning.
i.	2·6	2	5	71
ii.	2·9	4	6	73
iii.	2·8	11	11	77
	Average......	8·0	7·3	73·7

Normal Roots.

i.	2·8	18	18	12[illegible]
ii.	2·7	11	11	54
	Average......	14·5	14·5	88·5

In this experiment the effect of cutting off the tips lasted longer than in experiment I. ; for during the first two periods the

growth of the normal roots was much greater than that of the "cut" ones. But when the growth during 12 h. 10 m. is taken, the average growths are as 88·5 to 73·7, or as 100 to 83. Nor did the amounts of geotropic curvature correspond with the intensities of growth. None of the cut roots were geotropic. No. i. was bent at 9 millim. from the apex, so as to be 30° below the horizon; but this curvature did not increase. Nos. i. and iii. remained horizontal. The two normal roots were clearly geotropic, i. pointing vertically down, and ii. 60°–70° below the horizon. The growth of ii. was 54 perc ent. in the 12 h. 10 m., which is less than that of the two cut roots which remained horizontal.

Experiment III.—The roots were marked at 2 millim. and at 5 millim. from the tip, placed, as before, horizontally on damp peat:—

Cut Roots.

	Length of measured space. millim.	Percentage growth in 3 h. 10 m.	Percentage growth in 3 h. 5 m. additional.
i.	2·7	3	39
ii.	2·9	3	34
iii.	2·8	4	44
iv.	2·4	16	36
v.	2·6	11	60
	Average	7·4	42·6

Normal Roots.

i.	2·9	6	27
ii.	2·8	11	54
iii.	2·6	10	37
iv.	2·6	11	31
	...	...	60
	Average	9·5	41·8

Here, again, we find that the cut roots grow during the first period more slowly than the normal ones; for we have,

normal : cut : : 100 : 78.

On the other hand, during the second period of growth this state of things is reversed, and we have,

normal : cut : : 100 : 102.

None of the cut roots were geotropic; whereas all the normal ones were well bent except iii., and this was not one which grew especially weakly.

Experiment IV.—Eight roots were marked at 2 millim., 5 millim., and 8 millim. from the tip, thus giving two spaces each of about 3 millim. in length, for measurement. They were, as before, laid on damp peat after being operated on.

The following table gives the results of measuring the 3-millim. space furthest from the tip of the root, *i. e.* between the 5 millim. and 8 millim. marks.

Cut Roots.

	Lengths of measured space. millim.	Percentage growth in 3 hours.	Percentage growth in 3 more hours.
i.	2·7	23	35
ii.	2·6	15	28
iii.	2·7	11	27
iv.	2·8	12	32
	Average......	15·3	30·5

Normal Roots.

i.	2·6	17	3
ii.	2·7	37	24
iii.	2·6	14	33
iv.	3·0	31	33
	Average	24·8	30 (leaving out i.*).

The ratio between the average percentage growths are as follows:—

First period:—

cut : normal : : 100 : 162.

Second period:—

cut : normal : : 100 : 98.

This experiment shows again how transitory is the effect of the operation, since during the second 3 hours the growth of the cut roots was slightly greater than that of the uncut roots. Yet the normal roots were all markedly geotropic, while the cut roots showed no curvature. The following table gives the results of measuring the apical space between 2 and 5 millim. from the tip in the same roots as those just given.

* No. i. of the normal roots was excluded from the average of the third column because it had grown so little in the last period.

Cut Roots.

	Length. millim.	Percentage growth in 3 hours.	Percentage growth in 3 more hours.
i.	2·7	10	27
ii.	2·6	3	26
iii.	2·7	4	17
iv.	2·6	4	20
	Average	5·3	22·5

Normal Roots *.

ii.	2·6	21	29
iii.	2·8	8	30
iv.	2·8	20	39
	Average	16·3	32·7

Here the growth of the normal roots was much more vigorous during both periods. During the first period we have:—Normal : cut : : 100 : 33. For the second period:—Normal : cut : : 100 : 69. This experiment shows, however, some power of recovery in the "cut" roots.

Experiment V.—Roots 2–3 centim. in length; marked at 2 and 5 millim. from the tip, and the intervening space of about 3 millim. measured as before; 1·5 millim. cut off 3 roots. They were all grown vertically in damp air. In this way it was possible to continue microscopical measurements for longer periods; in the former experiments the uncut roots became geotropic, and had to be measured with a millimeter-scale or with compasses in the later periods. The present plan has the disadvantage that we do not know whether the roots become geotropic or not.

Cut Roots.

	Original lengths. millim.	Percentage growth in 3 hours.	Percentage growth in 3 more hours.	Percentage growth in 3 more hours.	Percentage growth in 21 h. 40 m. from the beginning.
i.	2·6	3	13	33	198
ii.	2·6	1	10	15	155
iii.	2·4	2	5	4	117
	Average	2	11·5	24	176·5

The average of the cut roots is taken from i. and ii., because iii. grew so differently from the others that it is probably abnormal. If iii. is taken into the averages, we have for the four columns

2	9·3	17·3	156·7

* In this case only three of the normal roots were measured.

Normal Roots.

Original lengths. millim.	Percentage growth in 3 hours.	Percentage growth in 3 more hours.	Percentage growth in 3 more hours.	Percentage growth in 21 h. 40 m. from the beginning.
. ... 2·6	6	10	36	208
ii. .... 2·6	7	7	15	143
iii. .... 2·7	11	23	23	196
Average	8	13·3	24·7	182·3

The ratios between the averages in the four columns are :—

	After 3 hours.	3 more hours.	3 more hours.	Whole growth.
Normal roots ...	100	100	100	100
Cut roots	25	86	97	97

Or, if we include "cut" root no. iii.,

Cut roots	25	70	70	86

As all the roots were grown vertically, we have no knowledge of the geotropic curvature ; but there can be little doubt that the roots whose growth is given in the first of the two above tables would have shown no geotropism, whereas the normal roots would probably have shown clear geotropism. It will be seen that the operation only produced a severe effect for 3 hours, and that after 6 hours the growth of the two sets of roots was practically equal.

Experiment VI.—In the following experiment the roots were, as in the last case, grown vertically in damp air. They were measured by means of a microscope sliding horizontally and having cross wires in the eyepiece ; the lateral displacements were read off to 0·1 millim. by a vernier. The measured space was between 2 and 10 millim. from the apex ; 1·5 millim. was cut off 3 of the roots.

Cut Roots.

Original lengths. millim.	Percentage growth in 4 hours.	Percentage growth in 19¾ hours additional.	Percentage growth from the beginning, *i.e.* in 23¾ hours.
i. .... 7·4	14	152	187
ii. .... 7·6	11	96	117
iii. .... 7·6	12	101	125
Average	12·3	116·3	143

Normal Roots.

i. .... 7·4	16	103	137
ii. .... 7·5	24	94	140
iii. .... 7·8	13	65	86
Average	17·7	87·3	121

Here we have the same effect as before obtained, namely, that the operation produces a great retardation in growth at first, from which the cut roots quickly recover and grow even more rapidly than the normal ones. Thus, taking the average growths and reducing those of the normal roots to 100, we have :—

	First period.	Second period.	Whole growth.
Normal	100	100	100
Cut	69·5	133	118

It would, perhaps, be fairer to leave out of account the first of the cut roots, which grew extremely vigorously, and the last of the normal ones, which grew badly. We then get :—

	First period.	Second period.	Whole growth.
Normal	100	100	100
Cut	57·5	100	87·4

Thus, even in this case, the growth of the cut roots during the second period of 19¾ hours was equal to that of the normal roots.

Conclusion.—It seems to me impossible, in the face of the above experiments, to say, as Wiesner has done, that the loss of geotropism in the cut roots is proportional to their diminished rate of growth *.

Experiments with Split Roots.—I shall now show that, even if cutting off the tips of the roots greatly retarded their growth, it would be a false conclusion to suppose that such retardation could account for the loss of geotropism.

Sachs has shown that roots may be split longitudinally and may nevertheless be geotropic †. If the root is split into a middle lamella (containing most of the vessels) and two side pieces, the middle portion will bend geotropically, if the root is so placed that the cut surfaces are vertical. He has elsewhere (p. 436) pointed out that splitting roots in *two* lamellæ ‡ retards the growth in a marked manner. These facts seemed to point to the conclusion that retardation of growth is not necessarily connected with loss of geotropism; and I therefore made the following ex-

* In those cases in which the rate of growth of the cut roots becomes greater than that of the normal ones after recovery from the effects of the operation, it would have been better if the cut roots had been observed for rather a longer period, to make sure that no geotropism occurred. But this is of no real consequence, as the effects of cutting off the tip are known from so many other observations.

† Arbeiten, Bd. i. p. 470.

‡ When split in three, he says that they grow "very strongly."

periments, in which the growth and geotropic powers of split roots are compared with those of "cut" roots, that is, of roots from whose apex 1·5 millim. has been cut off.

The roots were marked at 2 and 7 millim., and the intervening 5 millim. was measured, at first with the microscope, afterwards with an ordinary millimeter-scale. They were all laid horizontally in a tin box on a surface of damp peat.

Experiment VII.—

Split Roots.

	Original lengths. millim.	Percentage growth in about 17 hours. A.	Percentage growth in about 12 hours more. B.	Percentage growth in 12½ hours more. C.
i.	5·4	11	33	25
ii.	5·2	25	38	39
iii.	5·2	35	50	43
Average		23·7	40·3	35·7

Cut Roots.

	Original lengths. millim.	A.	B.	C.
i.	5·0	60	50	83
ii.	5·0	64	65	41
iii.	5·3	60	65	32
Average		61·3	60·0	52·0

If we take the averages of the cut roots as proportional in each column to 100, we have the following ratios :—

	A.	B.	C.
Cut	100	100	100
Split	38·7	67·2	68·7

Thus we see that the growth of the cut roots is much more vigorous than that of the split ones ; nevertheless it is the split roots alone which exhibit geotropism.

After the period of growth represented by column A, no geotropism was observed in either set. After period B, No. i. of the split roots was strongly geotropic, the extreme tip pointing within a few degrees of vertical, and the chord of the arc made by the terminal 6 or 7 millim. being 60° below the horizon ; No. ii. was bent sideways and was not geotropic ; No. iii. slightly geotropic, the end of the root being 30° below the horizon. None of the "cut" roots were geotropic. After period C the contrast was better marked : among the split roots, No. i., which had grown less than either of the others, was growing nearly vertically downwards ; No. ii. was distinctly, though not strongly, geotropic, the

apical 10 to 12 millim. were curved to a radius of 1 centim., and the tip of the root pointed at 45° below the horizon: in No. iii. the terminal part of the root grew at 75°–80° below the horizon. None of the cut roots were geotropic.

Experiment VIII.—The conditions were the same as in Experiment VII.

Split Roots.

	Original length. millim.	Percentage growth in 22½ hours.
i.	5	80
ii.	5	40
iii.	5·5	73
iv.	5	80
	Average	68·3

Cut Roots.

i.	5	130
ii.	5	140
iii.	5	160
iv.	5	160
	Average	147·5

In this case the average percentage growth of the "cut" roots, *i. e.* those whose tips had been removed, is more than twice that of the split roots, yet the former showed no clear geotropism, and only one of them a very slight curvature downwards. The split roots showed a variable amount of geotropism. i. had curved round so as to be bent at right angles in a horizontal plane; ii. had grown horizontally; iii. showed a distinct tendency to geotropism, though its chief curvature was in a horizontal plane; iv. was strongly geotropic, so that the last few millimetres were within a few degrees of vertical. After 24 additional hours, i. had become clearly geotropic (it is just possible, however, that it was directed downwards by growing against its own seed); ii. was only 20° below the horizon, but it gave the impression of being clearly more geotropic than any of the cut roots; iii. had its apex pointing at 60°–70° below the horizon. None of the cut roots had become geotropic.

Experiment IX., 2nd Feb. 1882.—The conditions the same as in above cases, except that the marks were made at 2 and 10 millim. from the tip of the root, so that the measured length was about 8 millim.

Split Roots.

	Original length of measured portion. millim.	Percentage growth in 22½ hours.
i.	8·5	148
ii.	8·2	80
iii.	8·2	193
iv.	8·0	143
v.	8·0	200
	Average	152·8

Cut Roots.

i.	8·2	244
ii.	8·0	275
iii.	8·0	213
iv.	8·1	172
v.	8·5	230
	Average	226·8

The ratio between the average growths of the two sets is

Cut 100,
Split......... 67·4.

None of the "cut" roots became clearly geotropic; iv. and v. had their terminal parts bent so as to be 10°–15° below the horizon; i., ii., and iii. remained horizontal. Of the split roots, i. was bent at right angles in a horizontal plane; ii. was curved downwards so as to be 30° below the horizon; iii. distinctly curved downwards: iv. was 45° below the horizon; v. pointed nearly vertically downwards.

These experiments show conclusively that there is no necessary connection between vigour of growth and power of curving geotropically. If Wiesner were right in explaining the loss of geotropism in "cut" roots to retarded growth, it is clear that split roots ought to be even less geotropic, since their growth is markedly less vigorous than that of cut roots. But I have shown that the reverse of this is the case: Wiesner's argument therefore falls to the ground.

I have already quoted the opinion of Sachs that the partial loss of geotropism of roots grown in damp air is not connected with their diminished rate of growth. This point of view leads on to what seems the rational way of looking at the question, namely, that geotropism, though accompanied and carried into effect by growth, cannot be treated as a mere distribution of growth of

different intensities on the upper and lower halves of a root. But it must be looked at as qualitatively different from longitudinal growth, and dependent on different conditions for its completion. It is only by accepting some such view as this, that we can attempt to understand the facts of the case, namely—that injury to the punctum does not seriously interfere with longitudinal growth, nor with geotropic growth if the stimulus of gravity has previously acted on the root when intact; whereas such injury does interfere with the process by which gravitation stimulates the root to subsequent curvature. Our view that the punctum is the part which receives the stimulus is, as a theory, consistent with the facts before us. But it is not the only possible theory; and it would be also rational to content one's self with saying, that for some unknown reason the injury to the punctum has a special paralysing effect on the power which roots possess of receiving the stimulus of gravitation.

Notes on Algæ from the Himalayas.

By Dr. George Dickie, F.R.S., F.L.S.

[Read May 4, 1882.]

The materials which form the subject of this brief notice were collected by Dr. Watt during the months of May and June, 1881. His report is, that the collections were made from pools and lakes in the Upper Batong Valley, Sikkim, at 15,000 to 18,000 feet above sea-level; I am not aware that any gatherings have been previously made at such altitudes anywhere. Unfortunately, the labels giving precise localities were accidentally destroyed: some were from moraine lakes at the Kanglanamo, and others from two moraine lakes in Prickchu Valley, between Kubra and Kinchinjunga.

I am indebted to my friend, Rev. G. Davidson, Parish Minister of Logie Coldstone, in county of Aberdeen, for valuable aid in recording the Diatoms, and also to Herr Grunow, one of the highest authorities in that department; Mr. Roy, secretary to our Aberdeen Natural-History Society, examined and noted the Desmids.

Siphonaceæ.

Vaucheria. Fragments only, and not sufficient for identification of the species; their diameter equal to ·001 of an inch.

Confervaceæ.

Conferva glacialis, *Kuetz.* This seems identical with the species found in glacial waters at Rosenlaui, Tête noire, &c.

Œdogoniaceæ.

Mr. Roy observed a peculiar *Œdogonium* with pear-shaped oogonia.

Zygnemaceæ.

Zygnema subtile, *Kuetz.* ? I record this with some doubt. In Rabenhorst's opinion it is a variety of *Z. Vaucherii*, a species widely diffused in Europe.

Scytonemaceæ.

Scytonema castaneum, *Kuetz.* Considered by some to be a variety of *Scytonema fasciculatum*, found in mountainous parts of Europe.

Desmidiaceæ.

Mr. Roy reported as follows: —"Altogether 13 species were observed, of which 7 appear to be new; the others are:—*Hyalotheca dissiliens*, W. Sm., var. *tridentula*, *Cosmarium Brebissonii*, Menegh., *C. pachydermum*, Lundell, *Tetmemorus granulatus*, Breb., *Penium digitus*, Ehrenb., *Cylindrocystis Brebissonii*, Menegh.; some refer this last to the genus *Penium*. These are all well-known European species. The new forms, not yet named, are four species of *Cosmarium* and three of *Staurastrum*."

Diatomaceæ.

1. Eunotia monodon, *Ehrenb.*
2. E. diodon, *Ehrenb.*
3. Cymbella amphicephala, *Näg.*
4. C. pisciculus, *Greg.*
5. C. Cessatii, *Grunow.*
6. Surirella linearis, *W. Sm.*
7. S. biseriata, *Breb.*
8. Navicula gracillima, *Pritch.*
9. N. borealis, *Ehrenb.*
10. N. subcapitata, *Greg.*
11. N. cryptocephala, *Kuetz.*
12. N. bisulcata, *Laednt.*
13. N. firma, *Kuetz.*
14. Stauroneis anceps, *Ehrenb.*
15. S. gracilis, *Ehrenb.*
16. S. platystoma, *Kuetz.*
17. Synedra oxyrhynchus, *Kuetz.*
18. S. lunaris, *Ehrenb.*
19. Gomphonema tenellum, *W. Sm.*
20. Himantidium majus, *W. Sm.*
21. H. arcus, *W. Sm.*
22. Odontidium mesodon, *W. Sm.*
23. O. hiemale, *Kuetz.*
24. Denticula tenuis, *Kuetz.*
25. Diatoma elongatum, *Ag.*
26. Tabellaria flocculosa, *Kuetz.*
27. Melosira nivalis, *W. Sm.*
28. Orthosira orichalcea, *W. Sm.*

Most of those recorded above are well-known European species. The following are rare in the collection, numbers 4, 6, 7, 12, 13, 17, 18. Numbers 6, 9, 22, 23, 27 are found at considerable altitudes in Europe; number 7 is found in Europe, N. America, and S. Africa; number 21 in Europe and N. America.

The following is the report of Grunow:—*Eunotia prærupta*, forma minor, also var. *nubicola*, Grun., and var. *bigibba*, Kuetz., which passes entirely into *E. robusta*, var. *diodon*, Grun., so that it would be better to name the latter *E. prærupta*, var. *Papilio*.

E. exigua, *Breb.*, var. paludosa, *Grun.*
E. gracilis, *Ehrenb.*
Diatoma vulgare, var. subacuta, *Grun.*
D. gracilis, *Ehrenb.*
Odontidium mesodon, var. parva, *Grun.*
Cymbella naviculæformis, var. altissima, *Grun.*
C. stauroneiformis, var.
Gomphonema augustatum, var.
Navicula mutica (rare).
N. borealis, var. subserians, and also var. intermedia.
N. bisulcata, small variety.
N. Brebissonii, var. (rare).
N divergens, var. glacialis.
N. divergentissima, *Grun.*, narrow variety.
Stauroneis anceps, var.
S. producta, *Grun.*, var. subproducta.
Melosira Roeseana, *Rabh.*, variety.

Note on Negative Heliotropism in *Fumaria corymbosa*, Desf. By B. Daydon Jackson, Sec. L.S.

[Read April 6, 1882.]

A somewhat remarkable case of negative heliotropism has been lately noticed by M. J. A. Battandier, Chief Physician to the Hospital at Mustapha, and Professor of Materia Medica at the Medical School in Algeria. In a letter to the President, received a short time ago, he states that in this plant, which usually grows in the crevices of overhanging rocks, there is a curious provision for depositing the fruit in a secure place. After flowering, as I understand M. Battandier, the peduncle lengthens; and, from being heliotropic, it bends away from the light towards any crevice which offers the greatest obscurity. This action of the plant is thus far advantageous to it, that in lieu of the fruit being scattered at haphazard, or falling in a direct line on to the sandy soil below, it is carefully deposited in a spot well adapted for the young plant. Following the usual course of the other species of the genus, the fruit on maturity would separate at the neck, and the corrugated shagreen-like outer surface would materially

assist in retaining it in the chink of the rock, until by germination it had succeeded in anchoring itself securely.

The figure given by Desfontaines in the 'Acta Nat. Soc. Paris,' shows the peduncles after flowering bending downwards in sucession—that is, away from the erect corymbose inflorescence. In the dried specimens which I have examined I have not detected any apparent lengthening of the peduncle after flowering. The lower pedicels in a corymb naturally are longer than the upper and younger ones; and this may possibly have given rise to the supposition referred to; but M. Battandier is emphatic in his statement.

The negative heliotropism in *Linaria Cymbalaria* is much less remarkable than in this *Fumaria*; for usually its capsules are merely turned toward the wall or rock on which it is growing, and when burst by a gust of wind, or its maturity alone, the seeds are scattered, falling by chance into any chink in the wall. *Fumaria* seems to perform an act of oviposition.

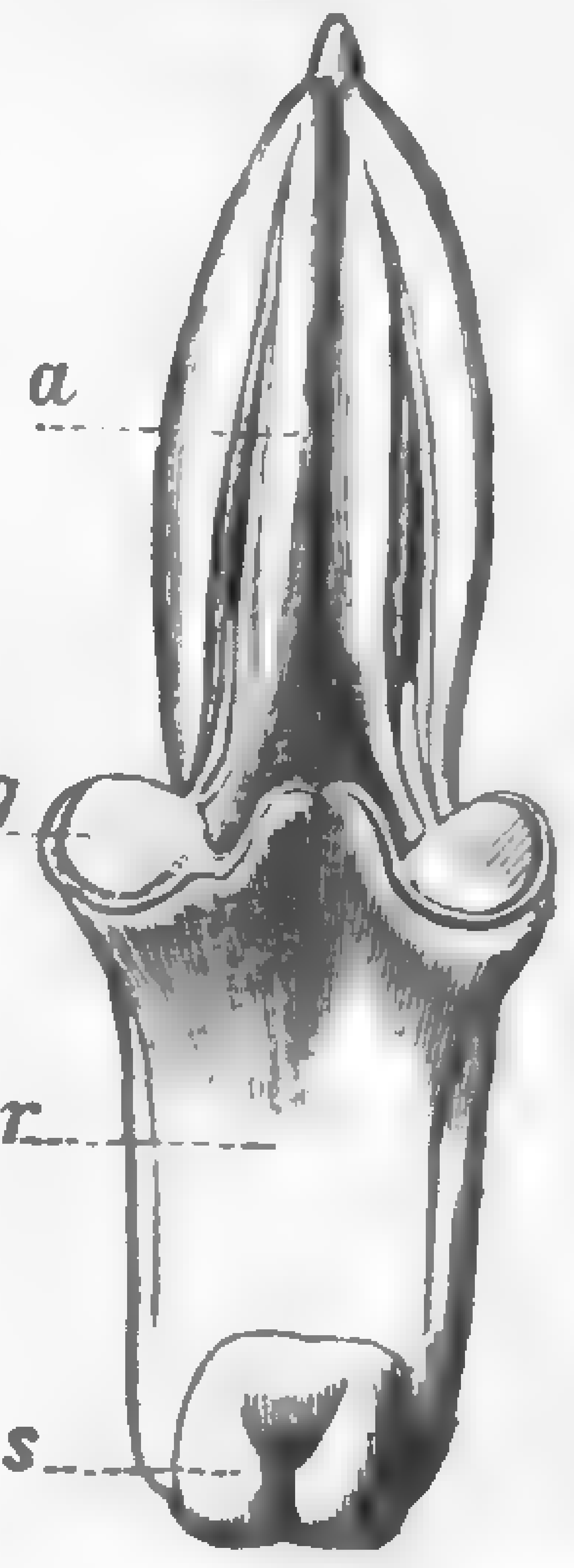
Notes on some Cape Orchids. By Harry Bolus, F.L.S.*

[Read May 4, 1882.]

Disa, Herschelia, &c.

The usual structure of the column in the genus *Disa* is well exemplified in *D. grandiflora*, L., the largest of the species. In fig. 1 the rostellum *r*, standing up behind the stigma *s*, is expanded at the summit into two recurved processes, which hold the widely parted disk-shaped glands *g*, terminating the caudicles of the pollinia contained in the anther *a*. The stigma *s* is three-lobed.

Fig. 1.



Column of *Disa grandiflora* (enlarged).

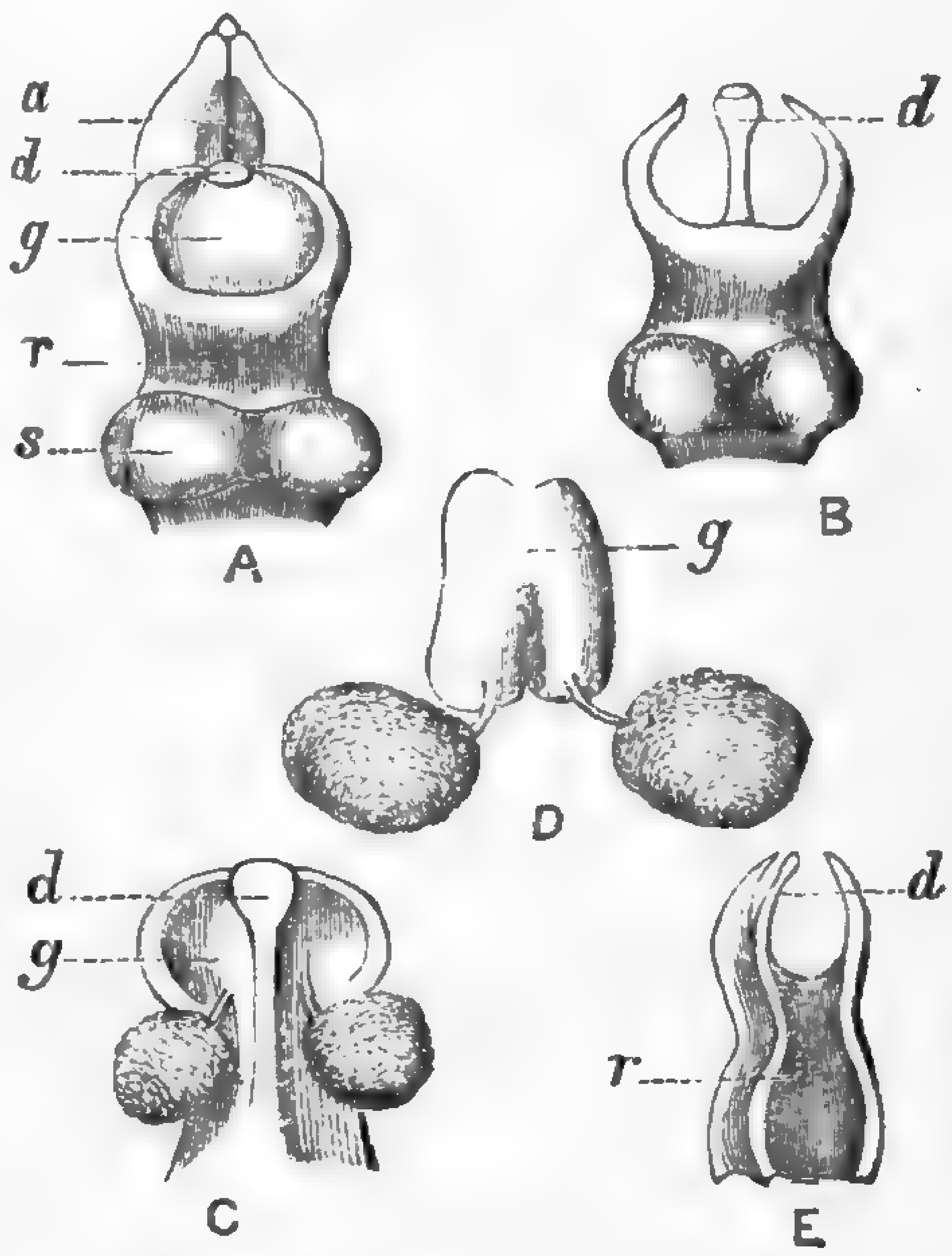
In several other species of *Disa* which I have examined there are slight modifications of this form of structure. The rostellum may be shorter, or bent further backwards, or the arms are less divaricate; but, with the exceptions now to be noted, the general structure remains the same.

In *D. barbata*, Sw., belonging to Lindley's section *Trichochilia*, I found a marked departure from the usual arrangement of the parts as above described.

* A List of published Species of Cape Orchideæ which was appended to this paper is unavoidably postponed in publication.—B. D. J.

In fig. 2 is represented the column of this species. A is the rostellum viewed anteriorly, showing two incurved arms holding a single gland *g*, the tip *d* of a dorsal process holding the gland in its place, *a* the anther turned back from the rostellum, and *s* the stigma, which is distinctly two-lobed. At B is shown the rostellum, with the gland and anther removed. At C a posterior view of the same, with the anther-case removed, showing the attachment of the pollinia. D the detached gland showing a median depression which receives the dorsal process *d*; but in the flowers I examined I observed no tendency in the gland to become divided along this depression into two glands. At E is shown an oblique view of the rostellum, every other part of the column being removed.

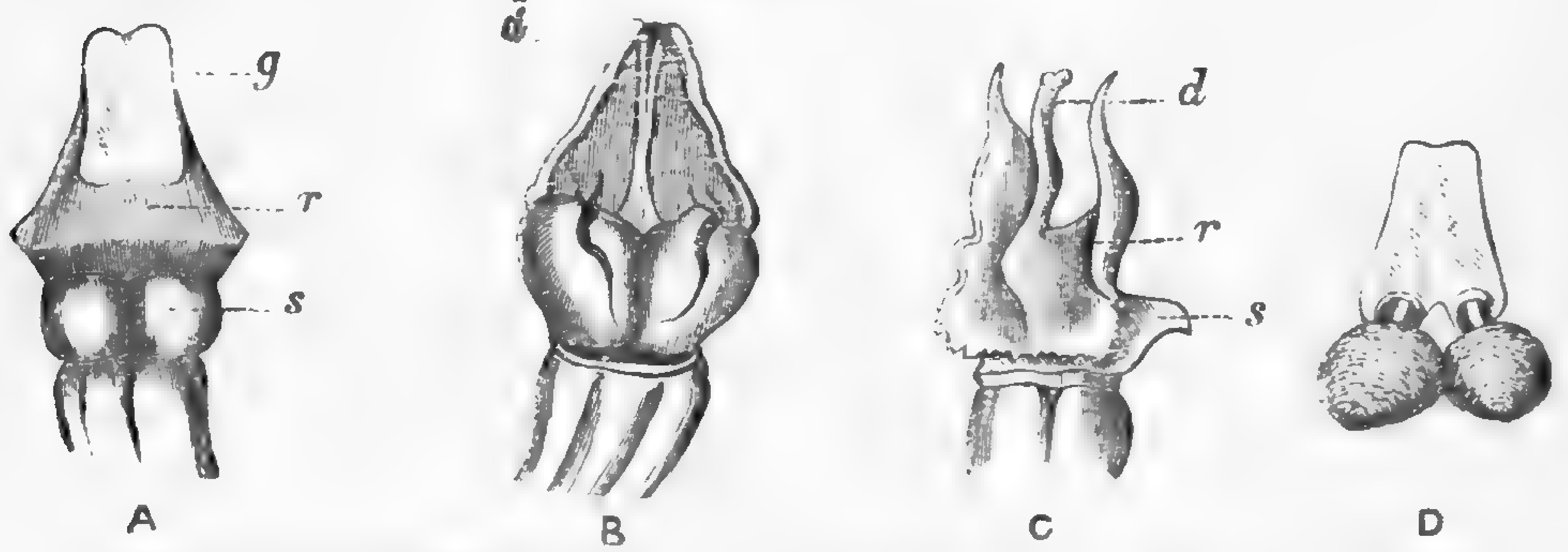
Fig. 2.



Column of *Disa barbata*, Sw. (variously magnified).

Subsequently (in February of the present year) I had an opportunity of examining living plants of *Disa graminifolia*, Ker,= *Herschelia cœlestis*, Lindl., and found the structure of the column to be closely similar to that of *Disa barbata*, Sw.

Fig. 3.



Column of *Disa graminifolia*, Ker, = *Herschelia cœlestis*, Lindl. (enlarged).

Fig. 3 shows the column of this species seen from different points of view :—A, anterior view, *g* the single gland, *r* the rostellum, *s* the two-lobed stigma ; B, posterior view, showing the dorsal appendage *d*; C, oblique view, with the anther removed ; D, gland, posterior view. In this species the dorsal process of the rostellum is bilobed at the apex.

Lindley separated *Herschelia* from *Disa* on account of the structure of the rostellum, which he thus describes :—“Rostellum tripartitum, laciniis lateralibus angustioribus acuminatis; appendice dorsali, lineari, bilobo, utrinque tuberculato ante antheram sito” (Gen. & Sp. Orch. p. 362). But he describes two glands, “glandulis duabus maximis truncatis corneis dentatis.” On this account I examined ten flowers; but never found more than one gland, nor did I observe any tendency in the gland to become divided. Nevertheless, there is some ground for suspicion that this character may not be constant. It is much more important that Lindley has omitted to notice the bilobed character of the stigma, which in this, as in *Disa barbata*, I believe is constant. This omission is to be accounted for by the fact that Lindley had very poor material at his disposal. He says himself:—“The structure of the column of this beautiful plant is very singular, and not to be well understood without better materials for examination than I have procured. A single flower is all that I have been able to analyze.”

I was led to think it probable that the *Disæ* of the section *Trichochilia* generally might present similar structural peculiarities. But in *Disa spathulata*, Sw., and *D. Charpentieriana*, Reichb. f., the rostellum is like that of *D. grandiflora*, and the pollinia terminate in distinct glands. *D. lacera*, Sw., and *D. multifida*, Lindl., are probably mere forms of *D. barbata*, Sw., described above; but I have had no opportunity of examining authentic specimens.

A number of specimens of an Orchid sent to me from Port Elizabeth, by Mr. J. R. Holland, as *Herschelia cœlestis*, exhibited the rostellum and bilobed stigma of that species; but differed in the shape of the lateral petals, in the labellum being more or less deeply lacerate, and in having two glands terminating the caudicles of the pollinia. Lindley describes the labellum of *Herschelia* as quite entire; and that is the case with all the Cape-Town specimens I have seen; but I suspect that both the latter characters may be variable.

The presence of caudicles connate in a single gland was relied upon by Lindley as the chief distinction of *Monodenia* from *Disa*. But with it were associated some other minor peculiarities which seem to warrant the maintenance of *Monadenia*; and it so happens that the two *Disæ* noted above as having only a single gland are those which least of all in the genus resemble *Monadenia*.

Mr. Bentham appears to be of the opinion (Linn. Soc. Journ., Bot. xviii. p. 357) that *Herschelia* should again be included in

Disa; though he remarks that, "generally the distinction between *Disa* and its nearest allies can scarcely be settled without a study of the living plants." I venture to suggest the restoration of *Herschelia*, distinguished from *Disa* by (1) its bilobed stigma, (2) its tripartite rostellum, and (3) pollinia generally united to a single gland. To *Herschelia cœlestis*, Lindl., hitherto the only species, should be added *H. barbata*, mihi (*Disa barbata*, Sw.). These two plants are similar in habit; and though they have also a certain resemblance in leaves &c. to the *Disæ* of the section *Trichochilia*, yet these latter have always a clawed labellum dilated at the apex; while in *Herschelia* the labellum is sessile.

Penthea, *Lindl.*

Lindley has separated the genus *Penthea* from *Disa* from the fact of the intermediate sepal having no spur. After the generic description, he says briefly:—"*Disa* differt sepalo altero ecalcarato."

In habit there is scarcely any difference; and the genera overlap in such plants as *Disa secunda*, Sw., described as having its intermediate sepal "dorsi saccato," and *Penthea atricapilla*, Harv., where it is described as "galea lineari-oblonga acuta basi plana apice cucullata." Harvey remarks (Lond. Journ. Bot. i. p. 17):—"The character of wanting a spur is only absolutely true in *P. patens*; in *P. melaleuca, obtusa*, and *filiformis* [*sic*] the galea is either saccate or umbonate." To this he might have added that in *P. atricapilla* it is cucullate. Elsewhere (Thesaur. Cap. p. 54), speaking of *Disa melaleuca*, Thunb., he observes:—"In *Disa* the spur varies extremely; and in *D. secunda* is nearly as obsolete as in the present plant."

The only members of the group which have a distinct and peculiar facies are *P. melaleuca* and the closely allied *P. atricapilla*. But the different appearance of these is due to the abbreviated, somewhat corymbose inflorescence, to the arrangement of the colours of the flower and the relative position of its parts, rather than to any structural distinctions.

On these grounds I cannot think that *Penthea* should stand. As Mr. Bentham points out (*loc. cit.*), the sections of *Disa* proposed by Lindley are very unsatisfactorily characterized; in any new arrangement *Penthea obtusa*, *P. filicornis*, and *P. reflexa* would be ranged with *Disa secunda*; while *P. melaleuca* and *P. atricapilla* would form a very distinct section.

AVICEPS, *Lindl.*

Aviceps is a genus founded by Lindley (Gen. and Sp. Orchid. p. 345) on a plant which he believed to be identical with Thunberg's *Satyrium pumilum*, Flor. Cap. ed. Schultes, p. 19. But Lindley, finding no petals, concluded that Thunberg was mistaken, and that the deficiency constituted a valid generic distinction.

I have not had any opportunity of examining an authentic specimen of Thunberg's, or of the plant which Lindley had before him, and believed to be identical with it. The specimens in the Kew and Lindleian herbaria are scanty and in bad condition. In the former, together with a single plant from Drège's collection marked *Aviceps pumila*, are mounted several specimens of a *Satyrium* of the ordinary typical structure, which is well known to me, though it is not, so far as I know, described, and in external appearance strikingly resembles the plant marked *Aviceps*.

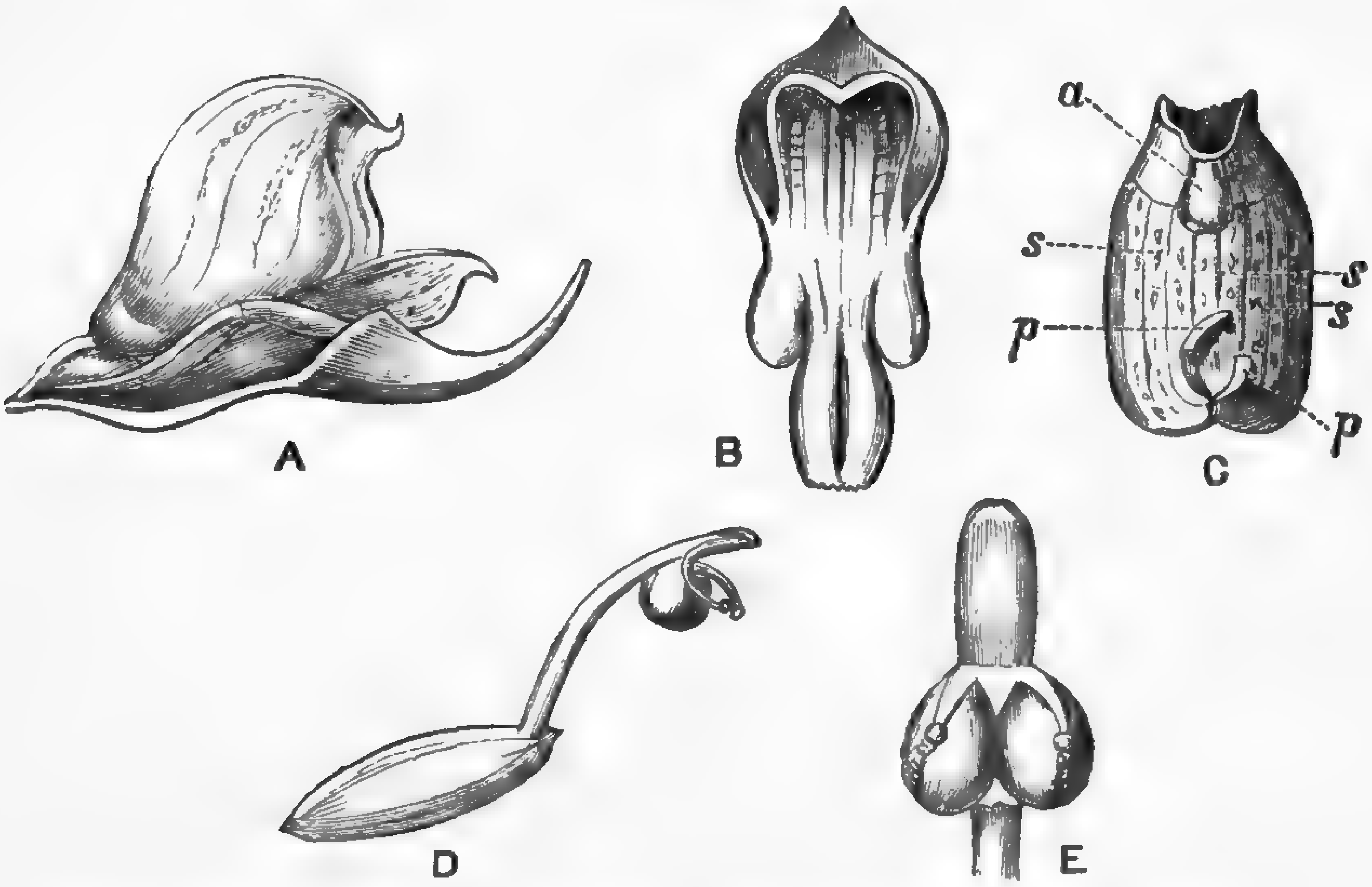
Since my return to Cape Town I have examined some recently gathered flowers, preserved in spirits of wine, of a plant which I can hardly doubt is Thunberg's *Satyrium pumilum*, and also Lindley's *Aviceps pumila*. This shows that Thunberg's description, drawn in all probability from the living plant, was fairly correct, and that Lindley, working from dried specimens, was mistaken*.

In fig. 4 (p. 238) A shows the flower viewed laterally, with its subtending bract; B the flower from beneath; C the three sepals *s*, and the two small lateral falcate petals *p*, the whole consolidated for the greater part of their length into a single oblong fleshy piece, which is furrowed and tuberculate above, while at the base is a bossy appendage *a*, which appears to serve the purpose of forcing-up an insect entering to rifle the nectaries against the glands of the pollinia, which are borne upon the highly arched column. D and E show the column and stigma.

Lindley observes (*l. c.* p. 346):—"I think this plant must be Thunberg's *Satyrium pumilum*; but he speaks distinctly of the petals of that species under the name of 'laciniæ duæ interiores

* This is not the first time that Thunberg's accuracy has been vindicated; and it reminds me of a remark of Ernest Meyer in the Preface to his Commentaries on Drège's Plants, p. vii:—"Id vero tacere nolim, plerasque Thunbergii descriptiones longe meliores esse, quam vulgo æstimantur. Fructificationis partes sæpius negligere, verum est, sed eo melius habitum referre solent; et ubi nimis longe a natura aberrare videntur, mallem credere, diversas diversorum plantas commutatas, quam a Thunbergio tam graviter peccatum esse."

Fig. 4.



Structural parts of the flower of *Satyrium pumilum*, Thunb.
(A to D enlarged twice and E thrice natural size.)

anteriores,' and of the sepals, which he calls 'laciniæ laterales exteriores.' The former are present, and are the sepals; but the latter have no existence. I presume, however, there has been some mistake in the description given by Thunberg; for in all other respects it agrees well with the present species."

Thunberg's description of the sepals and lateral petals is as follows:—" Laciniæ laterales exteriores lanceolatæ, acuminatæ; duæ interiores anteriores subfalcatæ et una intermedia (labellum) oblonga, inter se cohærentes, labium inferius obovatum planiusculum simul mentientes."

Any one reading the above with the description of the whole plant will, I think, be satisfied that the plant figured above is the same as Thunberg's. It differs in the most striking manner from any other *Satyrium* with which I am acquainted; yet it is a difference caused simply by the partial cohesion of organs usually more deeply parted, and by the rudimentary state of the lateral petals. Mr. Bentham, even on the supposition that these petals were absent, considers it unnecessary to separate this plant from *Satyrium*; and his judgment will therefore be strengthened by the confirmation of Thunberg's description.

It may be added that in the young flower the lateral petals are frequently so soldered down to the sepals as to be difficult of detection. The specimens examined were kindly communicated to me by Mr. Tyson, who gathered them near the Hex river, about October last.

The Action of Carbonate of Ammonia on the Roots of certain Plants. By CHARLES DARWIN, LL.D., F.R.S.

[Read March 16, 1882.]

MANY years ago I observed the fact that when the roots of *Euphorbia Peplus* were placed in a solution of carbonate of ammonia a cloud of fine granules was deposited in less than a minute, and was seen travelling from the tip up the root from cell to cell *. The subject seemed to me worthy of further investigation. Plants of the same *Euphorbia* were therefore dug up together with a ball of earth, and having been left for a short time in water, the roots were washed clean. Some of the finer transparent rootlets were then examined, and sections were made of the thicker roots, generally by my son Francis, who has aided me in many ways. All the cells were found to be colourless and destitute of any solid matter, the laticiferous ducts being here excluded from consideration. These roots, after being left for a few minutes or for several hours in solutions of different strengths, viz. from 1 to 7 parts of the carbonate to 1000 of water, presented a wonderfully changed appearance. A solution of only 1 part to 10,000 of water sufficed in the course of 24 hours to produce the same result. In well-developed cases the longitudinal rows of cells close to the tip of the root, with the exception of those forming the extreme apex, were filled with brown granular matter, and were thus rendered opaque. Long-continued immersion in water produced no such effect. The granular masses were square in outline, like the cells in which they were contained; but they often became rounded after a day or two; and this was apparently due to the contraction of the protoplasmic utricle. Above the dark-brown cells, which form a transverse zone close to the tip, and which apparently corresponds with the zone of quickest growth, the roots, as seen under a high power, are longitudinally striped with darker and lighter brown. The darker tint is due to the presence of innumerable rounded granules of brownish matter; and the cells containing them are arranged in longitudinal rows, while other longitudinal rows are destitute of granules. In a few instances the rows differed slightly in tint, and yet no

* 'Insectivorous Plants,' 1875, p. 64. The subject was at that time, 22 years ago, only casually investigated; and I believe that I erred greatly about *Lemna*, unless, indeed, some different species was then observed, or that the season of the year makes a great difference in the behaviour of the roots, which is not probable.

granules could be seen in the darker cells; and I suppose that this was owing to their being too minute to be visible. Occasionally, in the upper parts of the roots, the granules became confluent, and formed one or two small rounded masses of hyaline brown matter. The striped appearance sometimes extended from the tips of the finest rootlets close up to the stem of the plant.

On a casual inspection it would be said that the longitudinal rows of brownish and of almost colourless exterior cells regularly alternated with one another; but on closer examination, two or three adjoining rows of cells were often seen to contain granules, and in other places two or three ordinary rows contained only colourless fluid. In one instance many adjoining longitudinal rows contained granules; but the tendency to alternation was even here well shown, as the alternate rows differed in tint from including a greater or less number of granules. High up the roots the alternations often quite failed, as all the exterior cells contained granules. If a longitudinal row of cells with granules is traced up a rootlet, it is seen to be soon interrupted by one or more colourless cells; but I have traced as many as 18 cells in a row all containing granules. So, again, a longitudinal row of colourless cells changes after a time into one with granular matter. As a root thickens upwards, some of the longitudinal rows of cells divide into two rows; and a row containing granules may divide into two such rows, or into one with and another without granules; and so it is with dividing rows of colourless cells. I could not perceive the least difference in shape or size, or in any other character, between the cells of the same rank which contained and those which were destitute of granules.

Near the tip of the root it is the exterior cells which become charged, after immersion in the solution, with brown granular matter; and this often holds good with the cells of the root-cap. Higher up the root, the layer of cells formed by the alternating longitudinal rows with and without granules is sometimes bounded externally by a layer of empty cells, which, I suppose, had by some means been emptied of their contents, and were ready to be exfoliated. Besides the exterior cells with and without granules, many separate cells in the parenchyma at different depths from the surface, and all or several of the elongated endoderm-cells surrounding the central vascular bundle, are more or less filled with granular matter, none of which cells contained any solid matter before the roots were immersed in the solution.

I should have felt little surprise at the effect produced by the solution if all the cells of the same nature (for instance, if all the exterior cells or all the parenchyma-cells) had been equally affected. The strong tendency to alternation in the exterior cells is more especially remarkable. There is also another remarkable fact with respect to these latter cells, namely, that those containing the granules do not give rise to root-hairs, as these arise exclusively from the colourless and apparently empty cells. In longitudinal sections of one root, 62 hairs were traced down to such colourless cells; and I was not able to find a single one arising from a cell which contained granules. But I shall have hereafter to return to this subject.

With respect to the rate at which the granular matter is deposited, if a rootlet is placed under a cover-glass and irrigated with a few drops of the solution, some deposition occurs before the slide can be transferred to the microscope and the focus adjusted. A thin rootlet was therefore arranged for observation, and a drop of the solution (7 to 1000) placed on the edge of the cover-glass, and in 20 seconds the cells near the tip became slightly clouded. Another thin rootlet was placed with the tip projecting beyond the cover-glass, and the focus was adjusted to a point at a distance of ·07 inch from the tip, on which a drop of the solution was then placed, and the cells at the above distance became cloudy in 2 m. 30 sec.

Various other solutions, beside that of carbonate of ammonia, caused the deposition of granules in the same cells as in the foregoing cases. This occurred conspicuously with a solution of 4 parts of phosphate of ammonia to 1000 water; but the action was not so rapid as with the carbonate. The same remarks are applicable to nitrate of ammonia. A solution of one part of fuchsine, which contains nitrogen, to 50,000 of water distinctly acted. A solution of 2·5 parts of pure carbonate of soda to 1000 water caused, after 24 hours, the cells close to the tip to become very brown from being charged with fine granular matter; and higher up the rootlets, longitudinal rows of cells, either containing coarse granules or pale-brown fluid without any distinguishable granules, alternated with rows of colourless cells. Lastly, roots immersed for only one hour in a watch-glass of water, to which two drops of a 1-per-cent. solution of osmic acid had been added, presented an extraordinary appearance; for the exterior cells in alternate rows, some parenchyma, and most of the endoderm-cells contained much almost black granular matter.

The granules precipitated through the action of carbonate of ammonia are never afterwards, as far as I could judge, redissolved. Roots still attached to living plants were immersed in solutions of 1 part of the carbonate to 500, to 2000, and to 4000 parts of water, and granular matter was deposited in the cells in the usual manner. The roots were then left in damp peat or in water, with the stems and leaves exposed to the air and light, for various periods between 2 and 15 days. The roots were then reexamined at different times, and granules were found in almost every instance in the cells. But it should be noticed that though the plants themselves looked healthy, the finer roots were flaccid, and sometimes showed evident signs of decay; so that it was manifest that they had been much injured by the treatment to which they had been subjected, probably by their immersion in the solution.

With respect to the nature of the granules, I can say but little. They were not dissolved by long-continued immersion in alcohol or in acetic acid, or by irrigation with sulphuric ether. They were not dissolved by a 10-per-cent. solution of common salt, which was tried at the suggestion of Mr. Vines, who has found that this solution dissolves aleurone-grains either partially or completely. When sections or rootlets containing *freshly deposited* granules were left for a day or two in glycerine and water, these were sometimes broken up, so as to be no longer visible, and the cell-sap in this case acquired a brownish tint. When sections or thin rootlets were heated for a short time in a moderately strong solution of caustic potash, and afterwards left in it for a day or two, the granules were dissolved; whereas the hyaline globules in the laticiferous ducts were not dissolved. From these several facts I suppose that the granules are of the nature of protein.

After roots had been left for 2 or 3 minutes in water heated to a temperature of 210°–212° F., and were then placed in a strong solution of the carbonate of ammonia, no granular matter was deposited; and this seems to indicate that the action is a vital one. On the other hand, granules were often deposited in the cells, even the loose cells, of the root-cap, and it is very doubtful whether these could be alive. I may add that these root-cap cells were coloured, by a weak solution of fuchsine, of a brighter pink than those in other parts of the rootlets.

Other Euphorbiaceous Plants.—The exterior cells of the roots of *Euphorbia amygdaloides* were much less acted on (Nov. 16) by

a solution of carbonate of ammonia than those of *E. Peplus.* Here and there two and three cells in a row contained brownish granules, and these abounded in the elongated endoderm-cells. Nearly the same remarks are applicable to *E. myrsinites*, though in most specimens the cells with granules were still rarer. The roots of two fleshy species, *E. rhipsaloides* and *ornithopus*, did not appear to be at all affected by the solution.

Turning now to other Euphorbiaceous genera, the roots of *Poinsettia pulcherrima*, *Manihot Glaziovi*, *Croton oblongifolium*, and *Hevea Spruciana* were not affected. Nor were those of *Mercurialis perennis*, as far as the exterior cells are concerned; but here and there a single cell in the parenchyma became blue; but these cells were not carefully examined *. Judging from the cases presently to be given, they probably contained granules which had been precipitated by the ammonia solution.

On the other hand, the roots of *Phyllanthus compressus* were conspicuously acted on by an immersion of 21 hours in a solution of 4 parts of the carbonate to 1000 of water, though in a somewhat different manner from those of *Euphorbia Peplus.* In parts the exterior cells in many adjoining longitudinal rows contained brownish granules; while in other parts at no great distance many adjoining rows were colourless and empty—that is, contained no solid matter. For instance, in one place 13 longitudinal rows with granules ran alongside one another, then came a single row of empty cells, and then at least 9 rows with granules. In another place there were 13 adjoining rows of cells all empty. When one of these rows was followed up or down the root for some distance, it changed its character, either becoming or ceasing to be granular, and then resuming its former character. Close to the tips of the roots all the longitu-

* The rhizomes and buried parts of the stems of this plant are white; but after immersion for a day in the ammonia solution they became in parts either pale or rich blue. This change of colour occasionally occurred in parts exposed to the air which had not been subjected to the solution. As a similar change occurs in certain cells in the roots of various plants after their immersion in the solution, I asked Mr. Sorby to be so kind as to examine the rhizomes and underground stems of the *Mercurialis.* He informs me that he does not understand the change of colour; but he was unable to spare time for a full examination. He found that when the rhizomes and stems were boiled in alcohol, they yielded matter which was soluble in water, and which appeared to pass so rapidly into a brown substance with curious shades of green, that the real change was hidden. On the whole, the appearances differed a good deal from those observed by him in the case of blue flowers.

dinal rows of cells contained brownish matter; but this matter in several instances consisted of small dark-brown spheres, due apparently to the aggregation of granules. The endoderm-cells round the vascular bundle contained either similar spheres or granular matter.

As many adjoining rows of cells on the surface of the roots of this plant had the same character, an excellent opportunity was afforded for observing the relation of the root-hairs to the cells; and in several dissected roots it was manifest that, as a general rule, the hairs rose exclusively from the colourless empty cells; whereas none arose from those containing granules. Twice, however, partial exceptions to this rule were observed: in one case the exterior walls of two adjoining cells, and in another case those of four adjoining cells, projected, so that they formed short blunt papillæ which included granules; and these papillæ exactly resembled nascent root-hairs. It is not, however, certain that they would ever have become fully developed.

All the exterior cells close to the tip of the root in this case and in many others contained matter which was acted on by carbonate of ammonia; and I was led by various appearances to suppose at one time that this matter remained in all the higher cells until it was consumed in some of them by the formation of the root-hairs. These consequently would arise exclusively from cells in which no granules would be deposited when they were acted on by the solution. In opposition to this supposition is the fact, first, that root-hairs could be seen beginning to be developed from empty cells; and, secondly, that very many cells which were empty apparently had never produced root-hairs. Nor does this notion throw the least light on single cells in the parenchyma and on many cells, though not all, in the endoderm containing granular matter.

With another Euphorbiaceous plant, *Cœlebogyne ilicifolia*, the immersion for 20 hours of its roots, or of thin sections of the roots, in a solution of 4 parts of carbonate of ammonia to 1000 parts of water produced a singular effect; for many separate cells in the parenchyma and those in the endoderm surrounding the vascular bundle assumed a pale or dark blue, and sometimes a greenish colour. As far as I could judge, both the granules within these cells and the cell-sap became thus coloured. Irrigation with sulphuric ether did not affect the colour, though the many oil-globules in the cells were dissolved.

The foregoing observations on the Euphorbiaceæ led me to experiment on the roots of some other plants belonging to various families. At one time I erroneously imagined that there was some relation between the deposition of granules in certain cells and the presence of laticiferous ducts, and consequently an undue number of plants with milky juice were selected for observation. A solution of carbonate of ammonia produced no obvious effect on the roots of a small majority of the plants which were tried; but on several a slight, and on others a marked, effect was produced. I should state that when the exterior appearance of a root did not indicate any action, sections were rarely made; so that the interior cells were not examined. No obvious effect was produced with the following plants:—*Argemone grandiflora*, *Brassica oleracea*, *Vicia sativa*, *Trifolium repens*, *Vinca rosea*, *Hoya campanulata*, *Stapelia hamata*, *Schubertia graveolens*, *Carica Papaya*, *Opuntia boliviensis*, *Cucurbita ovifera*, a Begonia, *Beta vulgaris*, *Taxus baccata*, *Cycas pectinata*, *Phalaris canariensis*, a common pasture-grass, *Lemna*, and two species of *Allium*. It may perhaps be worth notice that the radicles, but not the hypocotyls, of seedlings of *Beta vulgaris* were completely killed by an immersion for 20 hours in solutions of either 4 or of only 2 parts of the carbonate to 1000 of water; and this occurred with no other plant which was tried.

With the following plants the solution produced some slight effect. The roots of a fern, *Nephrodium molle*, were immersed for 20 hours in a solution of 4 to 1000; and this caused the deposition of some brown granular matter in the cells near their tips; and more or less confluent globules could be seen in the underlying parenchyma-cells. So it was with an unnamed greenhouse species of fern; and in this case the almost loose cells of the root-cap contained brown granules. The roots of a *Ranunculus* (*R. acris*?) similarly treated exhibited near their tips brown granular matter. The tips also of the roots of *Dipsacus sylvestris* became, under similar treatment, almost black; and higher up the roots, here and there a single parenchyma-cell was coloured pale blue. This occurred in one instance when a rootlet was looked at 35 minutes after irrigation with the solution. Several roots of *Apium graveolens* were left for 20 and 24 hours in solutions of 4 and 7 to 1000; and in some cases brownish granules, more or less aggregated together, were deposited in some of the exterior cells, and a few of the deeper cells in the parenchyma

were coloured blue. The tips of the roots of *Pastinaca sativa* turned dark brown by a similar immersion; but this was due to the formation of orange-brown balls of matter near the vascular bundle; higher up the roots there were no granules in the exterior cells. The tips of the roots of *Lamium purpureum*, after an immersion of 18 hours in a solution of 4 to 1000, were rendered brown, and the cells contained innumerable pale-coloured hyaline globules. The older roots of *Leontodon Taraxacum* and of a *Sonchus* had their tips turned brown by the solution. With *Lactuca sativa* the tips were rendered opaque; but much granular matter was not deposited except in that of one rather thick leading root, and here short longitudinal rows of cells containing dark-brown granular matter alternated with rows of colourless cells; the almost loose cells of the root-cap likewise contained brown granules. In the several following cases a much more strongly marked effect was produced by the solution.

Urtica.—This plant, the common nettle, shall be first considered, as it is distantly allied to the Euphorbiaceæ, though the roots are not so much affected as in succeeding cases. Several roots were left for 27 hours in a solution of the carbonate (4 to 1000). In one of them the exterior cells were plainly tinted of a brown colour in many longitudinal rows, but they contained no visible granules; and these rows regularly alternated with others formed of colourless cells. In another part of this same root all the exterior cells were coloured dark brown, and contained visible granules, which were generally collected into heaps at one end of the cell, or were fused together in some instances into small brown spheres. In a second, rather thick root, there was a space in which all the exterior cells had become brown; but at no great distance rows of brown and colourless cells regularly alternated. In a third, rather thick, and in a fourth, thin root the alternation was extremely regular. Near the tip of a fifth (thin) rootlet two rows of a brown colour ran alongside one another in many places; but when these and other single rows were traced up the root, they changed into colourless rows, and afterwards reassumed their former character. Whenever the root-hairs were traced down to their bases, they were seen to arise from colourless cells. Neither granules nor brown fluid were observed in the parenchyma-cells nor in those surrounding the vascular bundle.

Some roots which had been left in water for several days were

longitudinally striped with very faint brown lines; and one cell was observed which included granules; so that plain water produces some effect. These same roots, after being irrigated with a solution of 7 to 1000, were left for 24 hours; and now the longitudinal rows of brown cells had become much darker, and presented a much stronger contrast with the colourless cells. Several of the brown cells moreover included granules, which here and there were aggregated into small dark-brown rounded masses.

Drosera, *Dionæa*, and *Drosophyllum*.—The roots of the plants belonging to these three closely allied genera are strongly acted on by a solution of carbonate of ammonia. In the case of a young plant of the *Dionæa*, all the exterior cells of the roots, after immersion for 24 hours in a solution of 4 to 1000, contained almost black or orange, or nearly colourless spheres and rounded masses of translucent matter, which were not present in the fresh roots. In this case, therefore, the exterior cells did not differ in alternate rows. Near the extremity of one of these roots many separate cells in the parenchyma, as seen in transverse sections, contained similar translucent spheres, but generally of an orange colour or colourless. The cells surrounding the vascular bundle abounded with much smaller dark-coloured spheres.

Three main or leading roots of *Drosophyllum lusitanicum* were cut off and examined before being immersed in the solution, and no aggregated masses could be seen in them. Two were left for 22 hours in a solution of 4 to 1000, and they presented an extraordinarily changed appearance; for the exterior cells in many rows from the tips to the cut-off ends of the roots included either one large, or, more commonly, several spherical or oval, or columnar masses of brown translucent matter. The columnar masses had sinuous outlines, and appeared to have been formed by the confluence of several small spheres. The loose, or almost loose, oval cells composing the root-cap included similar brown spheres; and this fact deserves attention. Two rows of cells containing the just-described masses often ran up the root alongside one another; and sometimes there were three or four such adjacent rows. These alternated with others which were colourless, and contained either no solid matter, or rarely a few minute pale spheres. These roots were carefully examined; and all the many root-hairs arose from the colourless rows of cells, except in some few cases in which the cells on both sides abounded to an unusual

degree with aggregated masses; and here root-hairs arose from cells including a very few minute spheres.

In longitudinal sections of the above roots, the cells in the parenchyma at different depths from the surface were seen to include spheres, but many of them were of small size and pale-coloured. There was no marked increase in the amount of aggregated matter in the cells closely surrounding the vascular bundle, as is so often the case with other plants.

The third cut-off root was placed under the microscope, and was irrigated with a solution of 7 to 1000. After 13 minutes very small translucent granules could be seen in many of the cells; and after 35 minutes several cells near the cut-off end contained moderately large spheres of translucent matter. But I suppose that the solution was too strong; for the granules disappeared after about 45 minutes, except close to the tip; and the higher parts of the root no longer presented a striped appearance. Nevertheless the large spherical, oval, and oddly shaped masses in the cells near the cut-off end remained perfect, and they were watched for the next $2\frac{1}{4}$ hours. During this time they slowly changed their shapes, but not afterwards, though observed for nearly 24 hours. For instance, two spheres in one cell became confluent and formed an oval mass; two other spheres ran together and formed a dumbbell-shaped body, which ultimately changed into a sphere; and, lastly, an irregular mass first became oval, then united itself with another oval mass, and both together became spherical.

Saxifraga umbrosa.—This plant, from its affinity to the Droseraceæ, was cursorily observed. Many of the exterior cells of roots which had been immersed for 19 hours in a solution of 4 to 1000 were filled with brown granular matter. Only two or three cells in a longitudinal row were thus filled; but sometimes four or five such short rows were grouped together; and these groups alternated with rows of colourless cells.

Sarracenia purpurea.—Two rootlets were left in water for 24 hours, but they presented no granules or aggregated masses. They were then irrigated with a solution of 7 to 1000, and in 20 minutes pale-brown aggregated masses could be distinctly seen near their tips. Two other, almost colourless, rootlets were left for 1 hour 10 minutes in the same solution; and now all the exterior cells contained brown granular matter, but much darker in some cells than in others. Some of the cells contained,

besides the granules, oval and occasionally spherical masses of transparent, almost colourless matter, which apparently did not change their shapes. The cells round the central vascular bundle included similarly shaped masses, but of a yellowish-brown colour. These roots and others were left for 24 hours in the solution of 7 to 1000, and their tips were now blackened. Some of the exterior cells, more especially those of the thicker roots, were filled with orange instead of brown granules ; while other cells contained oval, spherical, or oddly shaped masses of orange, instead of almost colourless or pale-brown translucent matter. Some of these masses consisted of an aggregation of small, partially confluent spheres of different tints of orange. In transverse sections it could be seen that the two exterior layers of cells and those surrounding the vascular bundle contained the above-described masses, while the more central parenchyma-cells abounded with grains of starch. A solution of 4 parts of the carbonate to 1000 of water sufficed to produce similar effects.

The root-hairs, after immersion in the solution, were not so transparent as is commonly the case, from including very fine granular matter, and from their shrunken protoplasmic lining being of a yellowish colour. The roots themselves were also usually opaque. Consequently the root-hairs were not easily traced down to their bases. They were distributed very unequally, being quite absent from the browner parts of the roots, while present on the parts which had remained pale-coloured. Notwithstanding this latter fact, it is very doubtful whether the rule of root-hairs arising almost exclusively from cells destitute of solid matter here holds good.

Pelargonium zonale.—A fresh root was examined, and the cells contained no granules. It was then irrigated with a solution of 7 to 1000, and in about 15 minutes granules could be distinctly seen in the exterior cells in alternate rows. Two other rootlets, after being left in water for 48 hours, were not at all affected. They were then irrigated with the same solution and reexamined after 24 hours; and now the exterior cells in rows, as well as those surrounding the vascular bundle, abounded with granular matter. Other roots were left for 48 hours in a solution of 4 to 1000; and the cells near their tips were so packed with dark-brown granular matter as to be blackened. Higher up the roots, the granules were pale brown, translucent, irregularly rounded, and often more or less confluent. In some dark-coloured rootlets the

cells included a few small spheres of dark brown matter instead of granules. Usually the cells containing the granules formed single longitudinal rows, which alternated with rows of colourless cells. But occasionally several adjoining rows included granules: thus in one place two adjacent rows of cells with granules were succeeded by an empty row; this by two alternations of granules and empty rows; then came two adjoining rows with granules, an empty row, and three adjoining granular rows. In another place an empty row was succeeded by five adjoining rows with granules; these by an empty row; this by three adjoining rows with granules, and this by an empty row.

After many casual observations, in which all the root-hairs appeared to arise from cells destitute of granules, this was found to be the case with 50 hairs which were traced down to their bases. With one problematical exception, not a single hair could be found which arose from a cell containing granules. In this one exceptional case, a hair seemed to spring from the transverse wall separating two cells; but with a good light and under a high power, the wall apparently consisted of two walls, separated by an excessively narrow clear space, as if a cell had here failed to be fully developed.

The solution likewise caused the precipitation of granules in the elongated cells surrounding the vascular bundle, and in some tubes or ducts within the bundle. The solution apparently does not act on cells which have been killed. The ends of a root were torn open, so that the vascular bundle was fully exposed; the root was then left for 24 hours in a strong solution of 7 to 1000, and no granules were deposited in the exposed cells round the vascular bundle; but by tearing open fresh parts of the same roots, these cells were found full of granules.

The granules were not dissolved by immersion for 24 hours in alcohol; but they were dissolved by a cold solution of caustic potash. The dissolution, however, took place very slowly; for though on two occasions the granules wholly, or almost wholly, disappeared after an immersion of 20 hours, yet with a thicker root they were not dissolved, though rendered browner, by an immersion for this length of time; but they finally disappeared after 18 additional hours in a fresh solution of the potash. In the cells round the vascular bundle, from which the granules had been dissolved by the potash, matter resembling oil-globules in appearance remained.

Lastly, two drops of a 1-per-cent. solution of osmic acid were added to ½ oz. of distilled water, and some roots were left in this fluid for 20 hours. They were affected in very different degrees. Some were only a little discoloured; and in such roots a single exterior cell here and there contained either blackish granules or small black spheres. Other roots were much blackened; and in these longitudinal rows of dark brown or blackened cells plainly alternated with colourless rows. The cells surrounding the vascular bundle and many of the parenchyma-cells also contained blackened granules. Hence it is probable that carbonate of ammonia likewise acts on some of the parenchyma-cells; but if so, the fact was overlooked, or accidentally not recorded, in my notes.

Oxalis Acetosella.—Roots were first examined, and then placed in a solution of 7 to 1000. Some slight degree of aggregation was seen in a few minutes. After 30 minutes all the cells near the tips contained rounded accumulations of granules. Higher up in one of the roots, single cells, or from two to five cells in a row, were filled with minute hyaline globules. In some places these had become confluent, so that they formed larger globules having a sinuous outline. The cells underlying the exterior layer likewise contained extremely fine granular matter. Still higher up the same root there were considerable spaces in which none of the cells contained granules. But again higher up, the granules reappeared. The root-hairs were numerous; but not one was seen which arose from a cell containing granules.

Roots of *Oxalis sepium*, *corniculata*, and of a greenhouse species with small yellow flowers were immersed in a solution of 7 to 1000, and granular matter was deposited in the layer of cells underlying the exterior layer. This occurred in the case of *O. sepium* in 20 minutes. With *O. corniculata* the cells with granules were isolated—that is, did not form rows; and the granules were either brown or of a bluish-green colour. In the case of *Oxalis* (*Biophytum*) *sensitiva*, the exterior cells of the roots, after immersion for 44 hours in the same strong solution, were not much affected; but some of the deeper parenchyma-cells contained dark-brown translucent spheres, and the elongated cells round the vascular bundle were almost filled with granular matter.

Fragaria (garden var. of the common strawberry).—Some white, almost transparent roots from a runner were examined (Dec. 12), and the cells contained no solid matter, except starch-

grains. They were then irrigated with a solution of 7 to 1000; and in from 10 to 15 minutes they became very opaque, especially near their tips. After being left a little time longer in the solution, longitudinal sections were made. The cells forming the exterior layer contained no solid matter, but the walls had become brown. There was much brown, finely granular matter in many of the parenchyma-cells at different depths from the surface; and these formed interrupted longitudinal rows, which alternated in the same zone with rows of empty colourless cells. Almost all the endoderm-cells likewise contained granules. In the parenchyma the cells which included much granular matter contained no starch-grains; while those abounding with starch-grains contained only a few or no granules. The fact was best seen after the sections had been irrigated with a solution of iodine; and they then presented a very remarkable appearance, considering how homogeneous they had been before being treated with the ammonia and iodine; for the fine granular matter was rendered still browner and the starch-grains of a beautiful blue. These roots were left for a week in diluted alcohol, and the granules were not dissolved.

Not a single root-hair could be found on these roots. A rooted stolon was therefore dug up and potted on Dec. 12th; it was then forced forwards in the hot-house, and afterwards kept very dry. When examined on Jan. 3rd the roots were found clothed with innumerable root-hairs; and they were then left for 23 hours in the solution of 7 to 1000. Sections of the thicker roots presented exactly the same appearances as described above; and the exterior cells, from which the root-hairs arose, were destitute of granules. The thinner roots differed somewhat in appearance, as the parenchyma-cells did not contain any fine granules, but in their places small, spherical, or oval, or irregularly-shaped masses or filaments of brown translucent matter, resembling a highly viscid fluid. There were also in these cells other still smaller colourless spheres. The cells, however, close to the tip of the root were filled with brown granular matter.

Solanum (*capsicastrum* ?, var. Empress).—Roots, after an immersion of 20½ hours in a solution of 4 to 1000, were split longitudinally and examined, but with no great care. The exterior cells did not appear to have been affected; but some of the parenchyma-cells close beneath the exterior cells contained minute aggregated masses of brown, opaque, or sometimes hyaline granules. More-

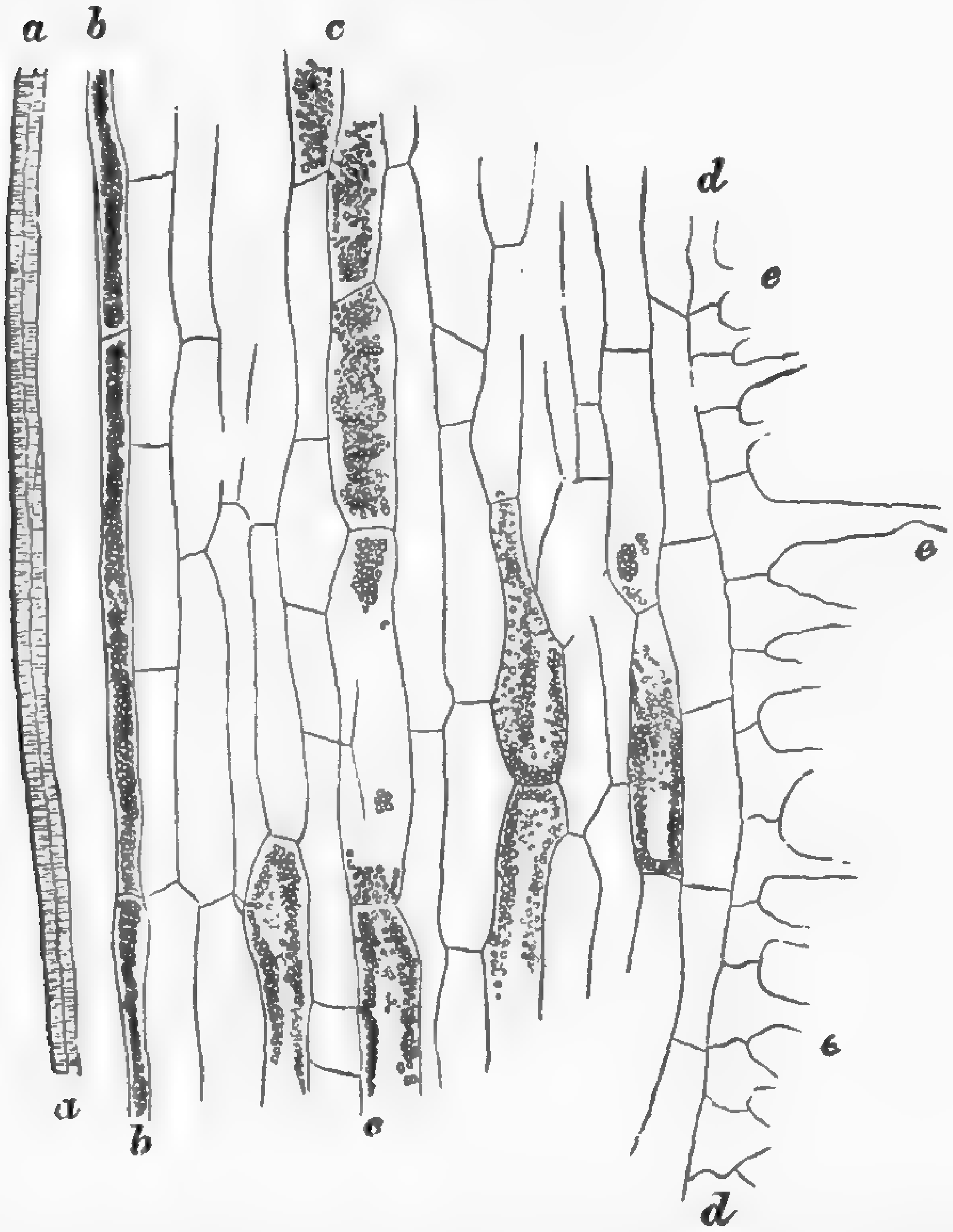
over many, but by no means all, of the elongated cells surrounding the vascular bundle included dark-brown fine granular matter. Three roots which had been left in water for the same length of time, viz. 20½ hours, were similarly examined, but their cells presented none of the above appearances.

Primula acaulis.—Several roots were left (Dec. 22) for 18 hours in a solution of 4 to 1000, and they were all much affected, except some of the thinnest rootlets. Many of the exterior cells contained granules within the shrunken protoplasmic utricle, which had contracted into one, two, or even three, oval or spherical bags, lying within the same cell. The rows of cells containing the granules showed some tendency to alternate with rows of empty cells. The granules were rendered orange-brown by iodine. The innumerable root-hairs all arose from the empty cells; and I saw only two partial exceptions, in which the outer walls of cells containing granules were produced into short papillæ, as in the formerly described case of *Phyllanthus,* and these resembled nascent root-hairs. Within one of these papillæ, granules surrounded by the shrunken utricle could be seen. In the parenchyma single cells were seen containing minute hyaline globules, which were colourless or pale or dark blue, or occasionally greenish or yellowish. Many of the endoderm-cells likewise contained more or less confluent hyaline globules; but these were colourless, and larger than those in the parenchyma. They resembled starch-grains so closely that they were tried with iodine, but were not coloured blue. Roots which had been kept for 48 hours in water exhibited none of the coloured or colourless globules; but these appeared when the roots were afterwards immersed for 24 hours in the ammonia solution.

Although it is certain that granules were deposited in the exterior cells in the case just described, yet in four other roots, after an immersion of 24 hours in the solution, no granules could be seen in any of the exterior cells. Some of the parenchyma-cells, however, were of a fine blue colour, and contained many globules or granules, but no starch-grains, while others contained starch-grains as well as some few globules.

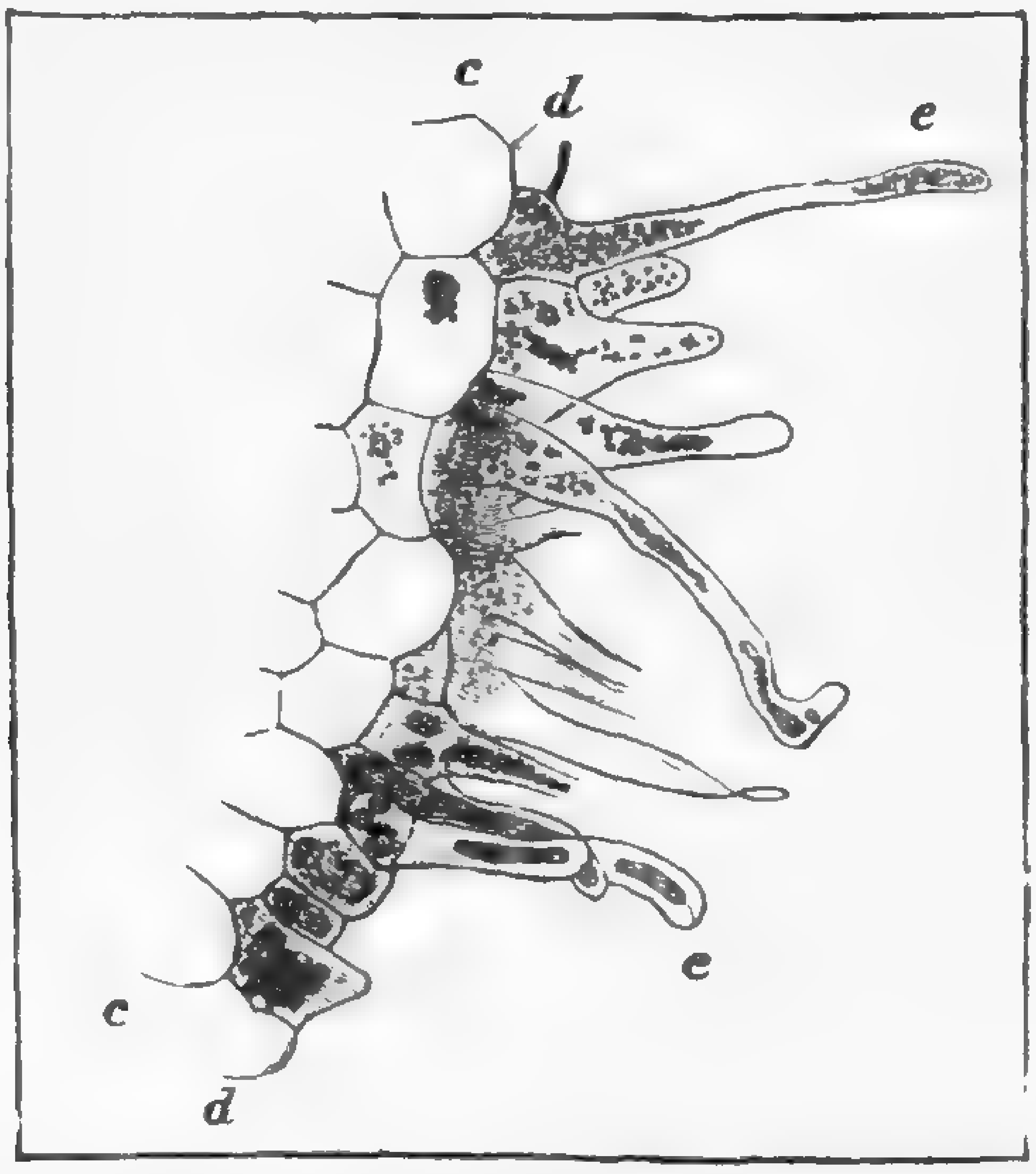
Cyclamen persicum.—Sections taken from roots of this plant which had been immersed in a solution of carbonate of ammonia presented an extraordinary different appearance from those of fresh roots. All the cells in the latter appeared empty, excepting those of the endoderm, which sometimes included a few very fine pale-

Fig. 1.



Longitudinal section of root of *Cyclamen persicum* after immersion in a solution of carbonate of ammonia, and deposition in some of the cells of granules. *a*, part of vascular bundle; *b*, endoderm-cells; *c*, parenchyma-cells; *d*, exterior cells of the root, bearing root-hairs, *e*, with their tips cut off. Drawing made by aid of a camera, magnified 260 times, but here reduced to two thirds of original scale.

Fig. 2.



Transverse section of another part of the same root, magnified as before, showing the exterior cells *d*, together with the root-hairs *e*, here containing granules.

coloured granules, unlike those in the same cells after immersion. Thick and thin roots were left for 22 hours in a solution of 7 to 1000, and the cells forming the exterior layer were filled over considerable spaces with green granules, while over other spaces they were empty. The granular and empty cells did not form regular alternate rows, as occurs in so many other plants; yet, as we shall presently see, there is occasionally some degree of alternation. The exterior cells with the green granules were so numerous in certain cases, that roots which had been pale brown before immersion were afterwards distinctly green. The green granules sometimes became aggregated into spherical, or oval, or elongated masses having a sinuous outline; and some of these are shown within the root-hairs in fig. 2. Many of the cells of the parenchyma, either standing separately or two or three in a row (as shown in fig. 1), contain similar green, or sometimes brownish, granules. Almost all the narrow elongated cells of the endoderm (*b*, fig. 1) likewise contain these granules, with merely here and there an empty cell. Although both kinds of cells often appear as if gorged with the granules, yet these really form only a layer adhering to the inside of the protoplasmic utricle, as could be seen when cells had been cut through. With some thick fleshy roots, after an immersion for 42 hours (and thick roots require a long immersion for the full effect to be produced) the green granules in the parenchyma-cells had become completely confluent, and now formed spheres of transparent green matter of considerable size.

The granules are not dissolved, nor is their colour discharged by sulphuric ether. Acetic acid instantly changes the green into a dull orange tint. The granules are not dissolved by alcohol. Their precipitation by the ammonia solution seems to depend on the life of the cell; for some transverse sections were examined and found colourless, as well as destitute of granules. They were then irrigated with a solution of 7 to 1000, and reexamined after 22 hours; and only a very few cells in two out of the five sections showed any trace of colour, which, oddly enough, was blue instead of green. The few coloured cells occurred exclusively in the thickest parts of the sections, where the central ones would obviously have had the best chance of keeping alive for some time. In these coloured cells a little very fine granular matter could be distinguished.

On most of the roots root-hairs were extremely numerous,

and they generally arose from cells destitute of granules; yet in many places whole groups of cells abounding with granules gave rise to well-developed root-hairs. Therefore the rule which holds good with so many plants, namely, that root-hairs arise exclusively from colourless cells destitute of granules, here quite breaks down. The granules extend from the cells into the hairs which spring from them, as is shown in fig. 2; and they here sometimes become confluent, forming rounded or elongated masses of transparent green matter. This matter within the tips of some of the hairs seemed to pass into a brownish fluid. It was repeatedly observed that where many hairs rose close together from cells containing the green granules, the tips of the hairs were glued together by cakes or masses of orange-coloured translucent tough matter. This matter could be seen, under favourable circumstances, to consist either of very thin homogeneous sheets or of aggregated granules. It was not acted on by an immersion of two hours in absolute alcohol or in sulphuric ether. The smaller globules were either dissolved or destroyed by sulphuric acid, while others were rendered highly transparent. The formation of this orange-coloured matter is independent of the previous action of ammonia; and I have noticed similar matter attached to the rootlets of many other plants. It is probably formed by the softening or liquefaction of the outer surface of the walls of the hairs, and the subsequent consolidation of the matter thus produced *. Nevertheless some appearances led me to suspect that the brownish fluid which was seen within the tips of the hairs enclosing the green granules may perhaps exude through the walls, and ultimately form the cakes of orange matter.

A few other solutions were tried. Roots were left for from 20 to 43 hours in a solution of 7 parts of pure carbonate of soda to 1000 of water, and in no case were granules deposited in the exterior cells; but some of these cells in longitudinal rows became brown; these alternated with rows of colourless cells. In one instance several of these cells included oval or spherical masses of an apparently tenacious fluid of a brown tint. Single cells in the parenchyma likewise became brown; others were dotted, like a mezzotinto engraving, with barely distinguishable granules, which,

* See some remarks on this liquefaction of the outer surface of root-hairs by my son Francis and myself in 'The Power of Movement in Plants,' 1880, p. 69.

however, in other cells were plainly visible; and, lastly, a few of these cells included spherical or oval masses of the same nature as those just mentioned in the exterior cells. Most or all of the endoderm-cells either contained a homogeneous brown fluid, or they appeared, from including excessively fine granules, like a mezzotinto engraving. In no case were any of the cells coloured green.

Some roots were immersed for from 20 to 44 hours in a solution of carbonate of potash of 7 to 1000; and these were affected in nearly the same manner as those in the soda solution. In the exterior cells, however, more granules were deposited; and these were oftener aggregated together, forming transparent orange-coloured spheres. The cells containing the granules or spheres were of a brown colour, and were arranged in longitudinal rows which alternated with rows of colourless cells. There were fewer granules in the parenchyma-cells than in the roots which had been subjected to the soda solution; and there were none in the endoderm-cells, even in roots which had been left immersed for 44 hours. A solution of phosphate of ammonia (4 to 1000) produced no effect on the roots after 43 hours' immersion.

Concluding Remarks.—The most remarkable conclusion which follows from the foregoing observations is that, in the roots of various plants, cells appearing quite similar and of the same homologous nature yet differ greatly in their contents, as shown by the action on them of certain solutions. Thus, of the exterior cells, one, two, or more adjacent longitudinal rows are often affected; and these alternate with rows in which no effect has been produced. Hence such roots present a longitudinally striped appearance. Single cells in the parenchyma, or occasionally two or three in a row, are in like manner affected; and so it is with the endoderm-cells, though it is rare when all are affected. The difference in aspect between sections of roots before and after their immersion in a proper solution is sometimes extraordinarily great. Of all the solutions tried, that of carbonate of ammonia acts most quickly, indeed almost instantaneously; and in all cases the action travels up the root from cell to cell with remarkable rapidity. With *Euphorbia Peplus* a solution of 1 part of the carbonate to 10,000 of water acted, though not very quickly.

When the action is very slight, the fluid contents of the cells are merely rendered pale brown. Nevertheless, judging from the gradations which could be observed, the brown tint is probably

due to the presence of invisibly minute granules. More commonly distinctly visible granules are deposited, and these, in the case of *Cyclamen persicum*, adhered to the inner surface of the protoplasmic utricle; and this probably is the case with other plants. From granules we are led on to globules more or less confluent, and thence to spherical or oval or oddly shaped masses of translucent matter. These were coloured pale or dark blue or green in seven of the genera experimented on; but usually they are brownish. The granules or globules are not acted on, except as far as colour is concerned, by alcohol, sulphuric ether, a solution of iodine, or acetic acid; but they are slowly dissolved by caustic potash. It has been shown in a previous paper that in the leaves of certain plants carbonate of ammonia first causes the deposition of granules from the cell-sap, which aggregate together, and that matter is afterwards withdrawn from the protoplasmic utricle which likewise undergoes aggregation. Something of the same kind apparently occurs in roots, judging from the occasional difference in colour of the aggregated masses within the same cell, and more especially from what has been described as occurring in the root-cells of *Sarracenia* and *Pelargonium*.

Other solutions besides that of carbonate of ammonia induce nearly, but not quite, the same effects. Phosphate of ammonia acted more slowly than the carbonate on the roots of *Euphorbia Peplus*, and not at all on those of *Cyclamen*. With this latter plant and with the *Euphorbia* carbonate of soda was efficient, but in a less degree than the carbonate of ammonia. In one trial which was made, carbonate of potash acted on the exterior cells, but hardly at all on those of the parenchyma and endoderm. An extremely weak solution of osmic acid was highly potent, and the deposited granules were blackened. This acid is poisonous; but it must not be supposed that the mere death of a cell induces deposition. This is far from holding good; so that, judging from several trials, cells which have been killed are not acted on even by carbonate of ammonia, which is the most efficient of all known agents.

I have not sufficient data to judge how generally roots are acted on by the carbonate of ammonia in the manner described. Those of 49 genera, many of which belong to widely separated families, were tried. The roots of 15 were conspicuously acted on, those of 11 in a slight degree, making together 26 genera;

while those of the remaining 23 genera were not affected, at least in any plain manner. But it should be stated that sections of all these latter roots were not made, so that the cells of the parenchyma and endoderm were not examined. We may therefore suspect that if various other reagents had been tried, and if sections had been made of all, some effect would have been observed in a larger proportional number of cases than actually occurred. I have elsewhere shown that the contents of the glandular hairs and of the epidermic and other cells of the leaves undergo aggregation in a considerable number of plants when they are acted on by carbonate of ammonia; and the roots of these same plants are especially liable to be affected in the same manner. We see this in 7 out of the 15 genera which had their roots conspicuously affected coming under both heads.

The question naturally arises, what is the meaning of matter being precipitated by a solution of carbonate of ammonia and of some other substances in certain cells and not in other cells of the same homologous nature? The fact of granules and spherical masses being formed within the loose exfoliating cells of the root-cap, as was observed in several instances, and conspicuously in that of *Drosophyllum*, apparently indicates that such matter is no longer of any use to the plant, and is of the nature of an excretion. It does not, however, follow that all the aggregated matter within the root-cells is of this nature, though the greater part may be; and we know that in the filaments of *Spirogyra* not only are granules deposited from the cell-sap which aggregate into spheres, but that the spiral chlorophyll-bands also contract into spherical or oval masses. The view that the granules consist of excreted matter is supported, to a certain extent, by their not being redissolved, as far as I could judge, in the roots of living plants of *Euphorbia Peplus*; and in this respect they differ in a marked manner from the aggregated matter in the leaves of *Drosera* and its allies. A larger amount of granular matter is deposited close to the tip of the root than elsewhere; and it might have been expected that where growth with the accompanying chemical changes was most rapid, there the largest amount of excreted matter would accumulate. It also deserves notice that there exists some degree of antagonism between the presence of these granules and of starch-grains in the same cells. On the other hand, it must be admitted that no excretion in the vegetable kingdom, as far as is at present known, remains dis-

solved in the cell-sap, or, as in the present cases, is precipitated only through the action of certain reagents.

On the view here suggested the exterior cells in many rows, some parenchyma-cells, and many or most of the endoderm-cells serve as receptacles for useless matter. It will, however, at first appear highly improbable that so many cells should serve for such a purpose. But this objection has no great weight; for in certain cases a surprising number of cells may be found which, instead of containing chlorophyll-grains like the surrounding cells, are filled with crystalline masses of carbonate of lime and other earthy salts which are never redissolved. Many isolated cells or rows of cells likewise contain gummy, resinous, or oily secretions and other substances, which, it is believed, are of "no further use in the changes connected with nutrition or growth"*. We thus see that useless or excreted matter is commonly collected in separate cells; and we thus get a clue, on the view here suggested, for understanding why the deposited granules and spherical masses are found in isolated cells or rows of cells, and not in the other cells of the same homologous nature; and this is the circumstance which, as lately remarked, at first surprised me most.

In the roots of plants the endoderm-cells commonly separate those of the parenchyma from the vascular bundle. Very little is known about their use or functions; so that every particular deserves notice. They resemble the exterior cells in their walls partly consisting of corky or cuticularized matter†; and we have here seen that they likewise resemble the exterior cells by serving as receptacles for the deposited granular matter, which, in accordance with our view, must be excreted from the inner parenchyma-cells or from the vascular bundle.

The fact of the granules being deposited in the exterior cells in one, two, or more adjacent longitudinal rows, which alternate with rows destitute of granules, is the more remarkable, as close to the tip of the root all the exterior cells are commonly gorged

* Sachs, 'Text-Book of Botany' (Engl. transl.), 1875, p. 113. Also De Bary, 'Vergleichende Anatomie,' pp. 142–143. When odoriferous oils or other strongly tasting or poisonous substances are deposited in cells, and are thus thrown out of the active life of the plant, there is reason to believe that they are by no means useless to it, but indirectly serve as a protection against insects and other enemies.

† On the nature of endoderm-cells, see De Bary, 'Vergleichende Anatomie,' 1877, p. 129.

with granular matter. It appears, therefore, that matter of some kind must have passed laterally from those rows which do not contain granular matter, after being acted on by the ammonia, into the adjoining rows. Why the useless matter should not pass out of the root through the outer walls of the cells, probably depends on the thickness and cuticular nature of the outer walls.

Pfeffer states that root-hairs are developed on the gemmæ, and apparently on the thallus, of *Marchantia polymorpha* from superficial cells which, even before the growth of the hairs, do not contain starch- or chlorophyll-grains; although these bodies are present together with matter of an unknown nature in the adjacent superficial cells. He has observed a nearly similar case with the roots of *Hydrocharis* *. No one else seems to have even suspected that root-hairs were not developed indifferently from any or all of the exterior cells. But it has now been shown that with many plants, with only one marked exception, namely that of *Cyclamen*, the root-hairs arise exclusively from cells in which granular matter has not been deposited after the action of certain solutions. This relation between the presence of hairs and the contents of the cells cannot be accounted for by matter, which would have been deposited if the roots had been subjected to a proper solution, having been consumed in the formation of the hairs; and this notion is wholly inapplicable to the cases described by Pfeffer. May we believe that cells filled with effete matter become unfitted for absorbing or transmitting water with the necessary salts, and do not therefore develop root-hairs? Or is the absence of hairs from the cells which contain the deposited matter due merely to the advantage which is commonly derived from a physiological division of labour? This and many other questions about the cells, in which granules or larger masses of translucent matter are deposited after certain solutions have been absorbed, cannot at present be answered. But I hope that some one better fitted than I am, from possessing much more chemical and histological knowledge, may be induced to investigate the whole subject.

* 'Arbeiten des botan. Instituts in Würzburg,' Band i. p. 79.

The Action of Carbonate of Ammonia on Chlorophyll-bodies.

By CHARLES DARWIN, LL.D., F.R.S.

[Read March 6, 1882.]

IN my 'Insectivorous Plants' I have described, under the term of aggregation, a phenomenon which has excited the surprise of all who have beheld it *. It is best exhibited in the tentacles or so-called glandular hairs of *Drosera*, when a minute particle of any solid substance, or a drop of almost any nitrogenous fluid, is placed on a gland: Under favourable circumstances the transparent purple fluid in the cells nearest to the gland becomes in a few seconds or minutes slightly turbid. Soon minute granules can be distinguished under a high power, which quickly coalesce or grow larger; and for many hours afterwards oval or globular, or curiously-shaped masses of a purple colour and of considerable size may be observed sending out processes or filaments, dividing, coalescing, and redividing in the most singular manner, until finally one or two solid spheres are formed which remain motionless. The moving masses include vacuoles which change their appearance. (I append here three figures of aggregated masses copied from my son Francis's paper †, showing the forms assumed.) After aggregation has been partially effected, the layer of protoplasm lining the walls of the cells may be seen with singular clearness flowing in great waves; and my son observed similarly flowing threads of protoplasm which connected together the grains of chlorophyll. After a time the minute colourless particles which are imbedded in the flowing protoplasm are drawn towards and unite with the aggregated masses; so that the protoplasm on the walls being now rendered quite transparent is no longer visible, though some is still present, and still flows, as may be inferred from the occasional transport of particles in the cell-sap. The granules withdrawn from the walls, together probably with some matter derived from the flowing protoplasm and from the cell-sap, often form a colourless, or very pale purple, well-defined layer of considerable thickness, which surrounds the previously aggregated and now generally

* Pfeffer, in his recent admirable work 'Pflanzenphysiologie' (B. ii. 1881, p. 248), speaks of the phenomenon as being in many respects interesting; and Cohn writes (" Die Pflanze," Vorträge aus dem Gebiete der Botanik, 1882, p. 361) in still stronger terms.

† Quart. Journ. Micr. Sci. vol. xvi. 1876, p. 309.

Fig. 1.

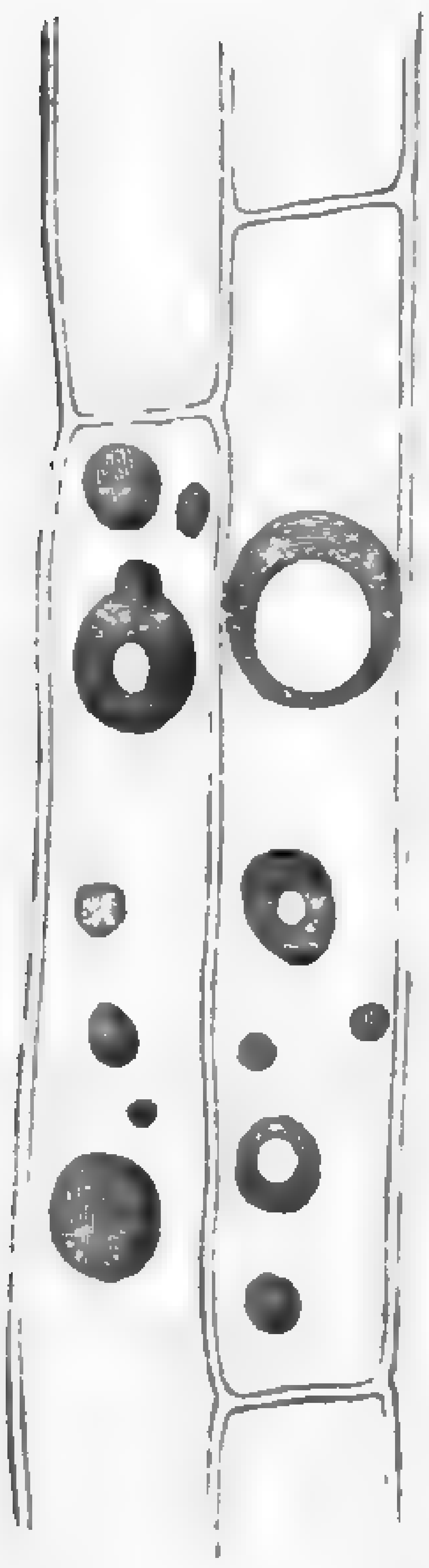
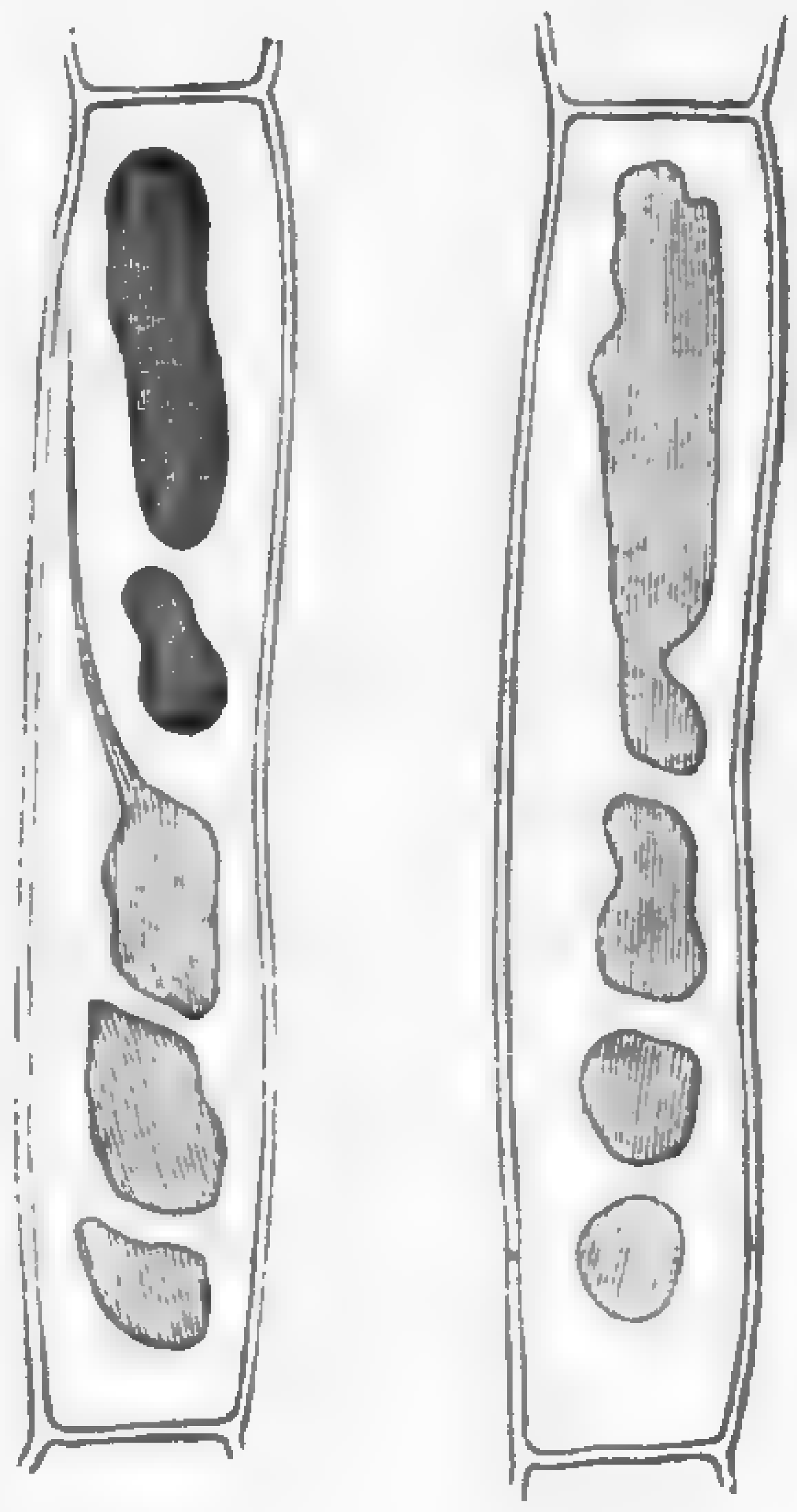


Fig. 2.

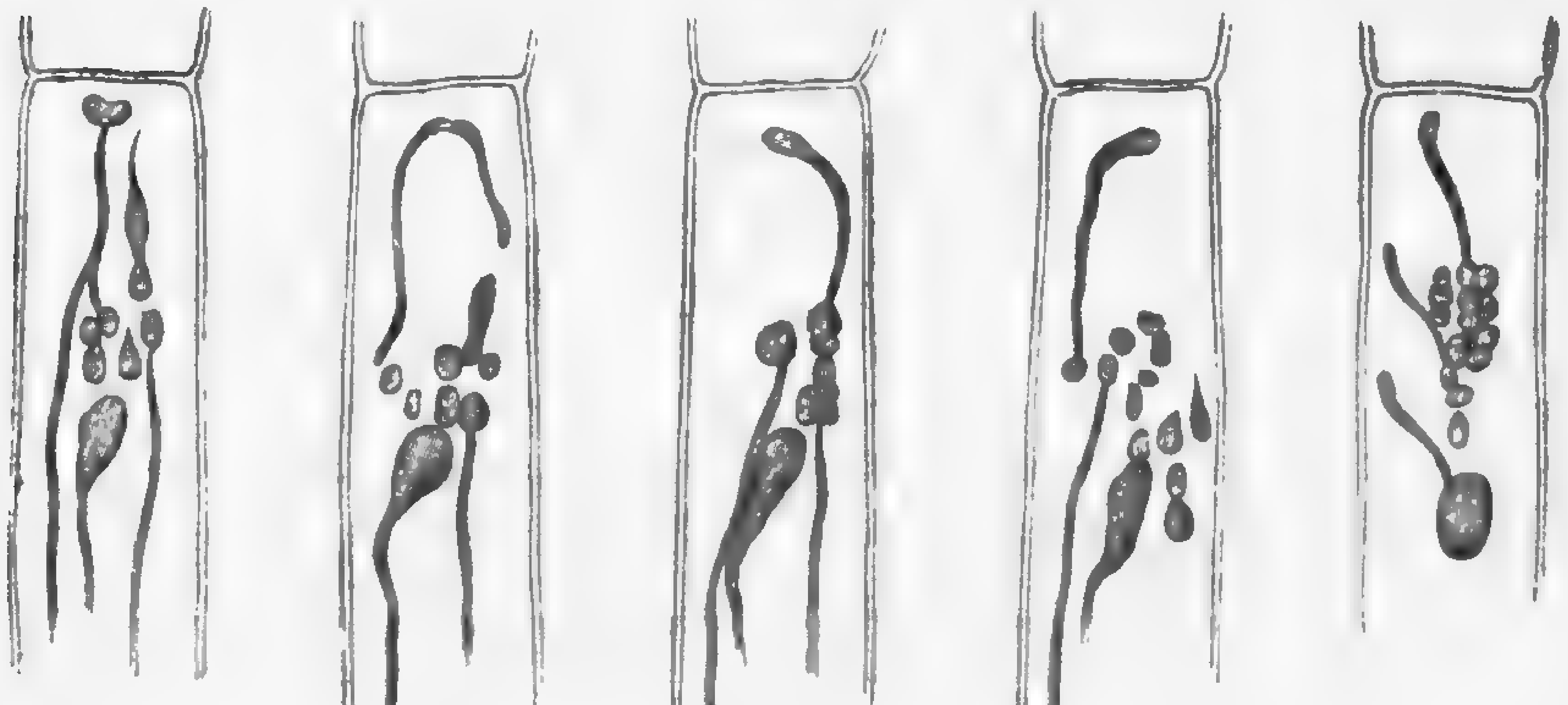


a *b*

Fig. 1. Cells in a tentacle of *Drosera rotundifolia*, showing aggregated masses after the action of carbonate of ammonia. Some of the masses with vacuoles.

Fig. 2. Aggregated masses undergoing redissolution. *b*, same cell as *a*, but masses drawn at a later period.

Fig. 3.



a *b* *c* *d* *e*

Fig. 3. *a*, *b*, *c*, *d*, *e*, the same cell drawn at successive short intervals of time, showing the aggregated masses produced by an infusion of raw meat. The changes of form occurred so rapidly that it was impossible to copy the appearance of the *whole* cell at a given moment.

spherical dark-purple masses. The surrounding layers or zones consist of solid matter, more brittle than the central parts of the aggregated masses, as could be seen when they were crushed beneath a cover-glass. It may be added that there is no *à priori*

improbability in some of the protoplasm being withdrawn, together with the imbedded granules, from the walls; for the whole of the protoplasm within the hairs of *Tradescantia* contracts, when subjected to great cold, into several spheres, and these, when warmed again, spread themselves out over the walls*.

The process of aggregation commences in the gland which is stimulated, and slowly travels down the whole length of the tentacle, and even into the disk of the leaf, but very much more slowly than the impulse which causes the basal part of the tentacle to bend inwards. It is a more interesting fact that when the glands on the disk are stimulated, they transmit some influence to the glands of the surrounding tentacles, which undergo throughout their whole length the process of aggregation, although they themselves have not been directly stimulated; and this process may be compared with a reflex action in the nervous system of an animal. After a few days the solid aggregated masses are redissolved. The process of redissolution commences in the cells at the bases of the tentacles and travels slowly upwards; therefore in a reversed direction to that of aggregation. Considering that the aggregated masses are solid enough to be broken into fragments, their prompt redissolution is a surprising fact; and we are led to suspect that some ferment must be generated in the disk of the leaf, and be transmitted up the tentacles. The double process of aggregation and of redissolution takes place every time that a leaf of *Drosera* catches an insect.

Aggregation is a vital process—that is, it cannot occur in cells after their death. This was shown by waving leaves† for a few minutes in water at a temperature of 65°·5 C. (150° F.), or even at a somewhat lower temperature, and then immersing them in a rather strong solution of carbonate of ammonia, which does not cause in this case any aggregation, although the most powerful of all known agents. If a tentacle is slightly crushed, so that many of the cells are ruptured, though they still retain much of their purple fluid contents, no aggregation occurs in them when they are similarly immersed, not-

* Van Tieghem, 'Traité de Botanique,' 1882, p. 596. See also p. 528, on masses of protoplasm floating freely within the cavities of cells. Sachs ('Physiologie Végétale,' p. 74) and Kühne ('Das Protoplasma,' p. 103) have likewise seen small freely-floating masses of protoplasm in the hairs of *Tradescantia* and *Cucurbita* which undergo amœboid changes of form.

† 'Insectivorous Plants,' p. 58.

withstanding that in closely adjoining cells which have not been killed, as could be seen by the protoplasm still flowing round the walls, aggregation ensued. So that the process is quite arrested by the death of a cell, and it is much delayed if a leaf, before being immersed in the solution, is kept for some time in carbonic acid; and this agrees with the well-known fact that protoplasm retains its activity only as long as it is in an oxygenated condition. When tentacles, including recently aggregated masses, are suddenly killed or much injured by being dipped into hot water, or by being irrigated with alcohol, acetic acid, or a solution of iodine, the aggregated masses suddenly disintegrate and disappear, leaving only a little fine granular matter; but this disintegration does not occur with the more solid masses which have been aggregated for some time.

From the several foregoing considerations, from the aggregated masses being of an albuminoid nature (as shown by the tests employed by my son Francis, and as is admitted by Pfeffer *), and from their incessant, long-continued amœba-like movements, I formerly concluded that not only these masses, but that the minute globules which first appear in the cell-sap consist, *at least in part*, of living and spontaneously moving protoplasm. And I feel compelled to adhere to my original conclusion, notwithstanding that such high authorities as Cohn and Pfeffer believe that the aggregated masses consist merely of condensed cell-sap. The movements of the masses, I presume, are considered by these botanists to be of the same nature as those curious ones described by Beneke as occurring in myelin when immersed in water and in a solution of sugar †.

From the doubts thus thrown upon my original conclusion, it seemed to me advisable to observe the action of carbonate of ammonia on grains of chlorophyll, as it is generally admitted that these consist of modified protoplasm. The grains not only change their positions under certain circumstances, which may be due merely to the movements of the streaming protoplasm in which they are imbedded, but they likewise have the power of changing their shapes, as has been recently proved by Stahl ‡.

* 'Pflanzenphysiologie,' Bd. ii. p. 248.

† 'Studien über das Vorkommen . . . . . von Gallenbestandtheil' (Giessen, 1862).

‡ See his interesting papers in the 'Botanische Zeitung,' 1880, pp. 298–413, and more especially p. 361.

They are also capable of self-division *. Now, if it can be shown that a solution of carbonate of ammonia tends to cause the grains of living chlorophyll to become confluent one with another and with previously aggregated masses, this fact would support the conclusion that the aggregated masses consist, at least in part, of living protoplasm, to which their incessant movements may be attributed. And it is the object of the present paper to show that chlorophyll-bodies are thus acted on in certain cases by carbonate of ammonia. The fact by itself possesses some little interest, independently of the light which it throws on the remarkable phenomenon of aggregation.

Dionæa muscipula.—The effects of carbonate of ammonia are best shown in the case of young, small, and thin leaves produced by starved plants, as these are quickly penetrated by the solution. Transverse sections of such leaves and of others were made before they had been immersed †; and the cells, including those of the epidermis, could easily be seen to be packed with grains of chlorophyll. It is, however, necessary to avoid examining a leaf which has ever caught an insect; for in this case many of the cells will be found filled with yellowish matter instead of with chlorophyll-grains. Several leaves were left for different lengths of time in solutions of different strengths; but it will suffice to describe a few cases. A small thin leaf was immersed for 24 hours in a solution of 7 parts of the carbonate to 1000 of water, and transverse sections were then examined. The cells near the margin of the leaf, throughout its whole thickness, did not now exhibit a single chlorophyll-grain, but in their place masses of transparent yellowish-green matter of the most diversified shapes. They resembled those of *Drosera* shown at fig. 3, if we suppose several of them to be pressed lightly together. Some of the masses in the same cell were connected by extremely fine threads. Spheres of more solid matter were sometimes included within the oddly-shaped greenish masses. The contrast in appearance between these sections and those taken from one corner of the same leaf before it had been immersed was wonderfully great. The sections were then clarified by being left for some time in alcohol, but not a grain of chlorophyll could be seen; whereas the fresh slices similarly clarified exhi-

* Van Tieghem, 'Traité de Botanique,' 1882, p. 493.

† These sections and many others were made for me by my son Francis, to whom I owe much information and other assistance.

bited with the utmost plainness the now colourless grains. The oddly-shaped green masses exhibited none of the movements so conspicuous in the case of *Drosera*; but this could hardly have been expected after the injury caused by slicing; and the leaves are much too opaque to be examined without the aid of sections. Some other sections from the same immersed leaf presented a rather different appearance, as they contained much extremely fine granular green matter, which became pale brown after being kept in alcohol. No chlorophyll-grains could be seen in any of these sections. After adding iodine (dissolved in water with iodide of potassium), many particles of starch became visible by being coloured blue; but none were present in the first described section. Some of the larger rounded aggregated masses were coated with blue particles. Others were quite free of such particles, and were coloured by the iodine bright orange.

A superficial slice was taken from a fresh leaf, showing the upper epidermic and glandular surface, and all the cells abounded with large grains of chlorophyll. But with a leaf which had been immersed for 24 hours in a solution of carbonate of ammonia (7 to 1000), a similar section presented a wonderfully different aspect; no chlorophyll-grains could be seen. Some of the cells contained one or two transparent yellowish spheres, which, it could hardly be doubted, had been formed by the fusion of previously-existing chlorophyll-grains. Other cells contained very fine brownish granular matter, and this apparently had been deposited from the cell-sap with its colour changed. This granular matter was generally aggregated into one or two either separate or more or less confluent spherical balls, having a rough surface. Sometimes a dark-brown granular sphere was surrounded by a zone of paler granular matter. In other cases brown granular spheres lay in the centre of transparent yellow spheres. In one case a sphere of this latter kind, with two others consisting exclusively of the yellowish transparent matter, were observed in the same cell. In other cases the brown balls were surrounded merely by an extremely narrow border of transparent matter. It appears that in these cases the granular matter had first been deposited, and then had become more or less aggregated into balls; and that afterwards the yellowish transparent matter, formed by the fusion of the modified chlorophyll-grains, had aggregated either round the granular matter or into independent spherical and oddly-shaped masses.

Transverse sections of other immersed leaves presented various appearances. In one cell a central transparent sphere was surrounded by a halo of brown granular matter, and this again by a zone of the transparent matter, and such matter quite filled some adjoining cells. In the cells of another leaf there were, throughout its whole thickness, yellow, greenish, orange, pale or very dark-brown spheres. Some of these latter spheres had a dark centre, which was so hard that it was cracked by pressure, and the line of separation from the surrounding zone of paler matter was distinct. Two brown spheres were in one case included within the same transparent sphere. Gradations seemed to show that the opaque granular matter ultimately passed into dark-coloured transparent matter. In these same sections there were some colourless or yellowish highly-transparent small spheres, which, I believe, were merely much swollen chlorophyll-grains. One, two, or more of such grains, while still partly retaining their outlines, sometimes clung to the darker granular spheres. When there were only one or two of them thus clinging, they assumed the shapes of half- or quarter-moons. It appeared as if such swollen grains when completely confluent had often given rise to the pale zones surrounding the granular spheres. The pale zones were rendered still more transparent by acetic acid; and on one occasion they quite disappeared, after being left in the acid for 24 hours; but whether the matter was dissolved or had merely disintegrated was not ascertained. This acid produces the same effect on recently aggregated pale-coloured or almost colourless matter in the tentacles of *Drosera*.

In one leaf a good many unaltered chlorophyll-grains could still be distinguished in some of the cells; and this occurred more frequently in the thickest part of the leaf, near the midrib, than elsewhere. In one section the chlorophyll-grains had run together, and formed in some of the cells narrow green rims round all four walls. In many sections, more especially in those in which the process of aggregation had not been carried very far, there was much extremely fine granular matter, which did not resemble smashed or disintegrated chlorophyll-grains, such as may often be seen in sections of ordinary leaves. This granular matter occasionally passed into excessively minute, transparent, more or less confluent globules.

Judging from these several appearances, we may conclude that carbonate of ammonia first acts on the cell-sap, producing a gra-

nular deposit of a pale brownish colour, and that this tends to aggregate into balls ; that afterwards the grains of chlorophyll are acted on, some swelling up and becoming completely confluent, so that no trace of their original structure is left, and others breaking up into extremely fine greenish granular matter, which appears likewise to undergo aggregation. The final result is the formation of balls of brown, and sometimes reddish, granular matter, often surrounded by zones, more or less thick, of yellowish or greenish, or almost colourless transparent matter. Or, again, spheres, ovals, and oddly-shaped masses are formed, consisting exclusively of this transparent yellowish-green matter. As soon as the process of aggregation has been thoroughly carried out, not a grain of chlorophyll can be seen.

Drosera rotundifolia.—It is advisable to select for observation pale reddish leaves, as the dark-red ones are too opaque; and the process of aggregation does not go on well in the small completely green leaves which may sometimes be found. The tentacles, which are merely delicate prolongations of the leaf, are from their transparency well fitted for observation. In sections of the disks of fresh leaves, the cells of the epidermis are seen to abound with grains of chlorophyll, as well as those of the underlying parenchyma. The bases of the exterior tentacles and the part immediately beneath the glands are generally coloured pale green from the presence of chlorophyll-grains in the parenchyma; and some occur throughout the whole length of the longer tentacles, but are not easily seen on account of the purple cell-sap. Sometimes the epidermal cells of the longer tentacles include chlorophyll-grains; but this is rather a rare event. The footstalks of the short tentacles on the disk are bright green, and invariably abound with grains of chlorophyll.

A pale leaf, in which the basal cells of the exterior tentacles contained numerous grains of chlorophyll, was left for 24 hours in a solution of only 2 parts of the carbonate to 1000 of water; and now innumerable greenish spheres, resembling oil in appearance, were present in these cells, and the ordinary chlorophyll-grains had in most places disappeared. Nevertheless in several cells some swollen grains were still distinct. Other cells contained fine granular or pulpy green matter collected into masses at one end. In a few other cells the chlorophyll-grains had run together, forming a continuous green rim with a sinuous outline attached to the walls. In fresh leaves the guard-cells of the

stomata include grains of chlorophyll; but these, after the leaf has been immersed in the carbonate, almost always become fused into a few nearly colourless spheres.

Sections made from leaves which had been left for 22 hours in a solution of 4 to 1000 exhibited, in the upper and lower epidermal cells of the disk, and in the cells of the parenchyma near the bases of the exterior tentacles, greenish spheres; and in such cells there were no chlorophyll-grains, but they were still present in some few of the epidermal cells which did not contain aggregated masses, and they abounded in the parenchyma in the middle of the disk, where there were only a few green spheres. These sections were irrigated with the solution of iodine, and the green spheres became yellow; and many minute elliptical particles of starch, coloured blue, could now be seen. Such particles were not visible in the sections of fresh leaves, and I believe that they had been imbedded within the chlorophyll-grains, from which the enveloping protoplasm had been withdrawn to form the green spheres.

One of the above leaves was left in the ammonia solution for three days, by which time it had become flaccid, being evidently killed. The numerous green spheres were blackened, but perfectly retained their outlines. No chlorophyll-grains could be seen, but many particles of starch. When leaves were left for some time in a solution of 7 to 1000, much pulpy green matter and innumerable spheres were sometimes formed, but no large aggregated masses; so that in these cases the solution appeared to have been too strong. The degree to which the grains of chlorophyll are acted on varies much from unknown causes; for in some tentacles, which exhibited strongly-marked aggregation after being left for 36 hours in the stronger solution, the grains could still be seen, but only after they had been cleared by immersion in acetic acid.

A leaf was laid on a glass plate kept in a damp chamber, and two or three tentacles at one end were covered with thin glass, so as to prevent their bending, and were irrigated with the ammonia solution of 7 to 1000. After 24 hours and 48 hours these tentacles included many dark-purple aggregated masses; nevertheless plenty of chlorophyll-grains were still visible. In the disk of this leaf, however, near the bases of these tentacles, there were some spheres of a fine green tint, and others purple in the centre surrounded by a distinctly defined green zone; and in

most of the cells containing these spheres not a grain of chlorophyll could be distinguished. That the green surrounding zones had been derived from the chlorophyll-grains is, I think, certain; for the purple colour of the central spheres showed that the cell-contents had not been originally green. Other cells in these same sections included irregularly-shaped masses of a purplish-green colour; and these were observed slowly to change their forms in the usual manner. When acetic acid was added to them, the green transparent spheres and the zones of similar green matter round the purple spheres instantly disappeared, either from being dissolved or, as seems more probable, from being killed and suddenly disintegrating. On another occasion boiling water and alcohol produced the same effect on the spheres. Tentacles still retaining their chlorophyll-grains, but with many very pale-coloured homogeneous aggregated masses (which were seen in movement), were irrigated with acetic acid; and it was curious to observe how instantaneously they became filled with small transparent spheres. In a short time, however, the outlines of the larger masses were alone left; then these disappeared, and finally the small enclosed spheres. On the other hand, some dark-coloured solid aggregated spherical masses did not disappear when left for 24 hours in acetic acid.

The effect of the ammonia solution (4 and 7 to 1000) on the epidermal cells of the upper surface of the disk was now more especially observed. In some cases all these cells which, as already stated, invariably contain many chlorophyll-grains, included after immersion in the solution only a single or several green transparent spheres; but more commonly the spheres were very dark purple or brown. Sometimes a central sphere, which was so solid that it could be cracked, was surrounded by a well-defined paler zone. Numerous gradations could be traced, showing that several small spheres and irregularly shaped globules often coalesce, and thus form the larger rounded masses. It was repeatedly observed that when the epidermal cells contained only one or two large spheres, not a single grain of chlorophyll could be seen. It is surprising that dark purple or brown or almost black spheres should be formed in the epidermal cells of green leaves; for before immersion the cell-contents were colourless, with the exception of the chlorophyll-grains; but the fact is less surprising when it is known that these cells turn more or less red as they grow old if they are exposed to a

bright light. In some of these leaves the basal cells of the longer exterior tentacles had become beautifully transparent from the aggregation of their contents into green or greenish-purple masses; and here no chlorophyll-grains could be seen; but in other parts of the same tentacles, where the aggregated masses were of a purple tint, the chlorophyll-grains were still plainly visible.

Finally, it appears certain that in the leaves of *Drosera* the grains of chlorophyll, if left long enough in a weak solution of the carbonate, sometimes break up and form translucent greenish globules, which are much smaller than the original chlorophyll-grains; and that these, by coalescing, form larger masses, which again coalesce into a few spheres or into a single one. In other cases the chlorophyll-grains swell and coalesce without having previously broken up into globules. During these various changes the aggregated masses often become coloured by the modified cell-sap, more especially in the case of the epidermal cells; or they may form a zone round the already aggregated cell-sap, in which case a dark central sphere is surrounded by a less dark or by a light-green transparent zone of matter.

It remains to be considered whether the grains of chlorophyll, after complete fusion or aggregation, are ever reformed and re-assume their normal positions on the walls of the cells. Although the purple aggregated masses within the tentacles are soon redissolved, the cells becoming refilled with transparent purple fluid, it by no means follows that the chlorophyll-grains should be reformed; and such a capacity would be an interesting point. To ascertain whether this occurred, drops of a weak solution of carbonate of ammonia (2 to 1000) were daily placed during 5 days on several leaves on a growing plant; but, to my surprise, the tentacles remained after the first day expanded, with their glands bright red and copiously secreting, and they exhibited little aggregation. Large drops of a solution of 4 to 1000 were next placed on three reddish leaves, fresh drops being added in about 18 hours. After an interval of $41\frac{1}{2}$ hours from the time when the drops were first placed on the leaves, three short central tentacles on one leaf were examined, and the cells were seen to be filled with quickly moving aggregated masses, and not one grain of chlorophyll could be distinguished. In 66 hours after the drops had been given the leaves were well syringed with water; and now the central tentacles of a second leaf were examined, in

which there was much aggregated matter and no chlorophyll-grains. A third leaf was examined 5 days after the drops had been given, and the aggregated masses appeared to be breaking up into small highly transparent spheres. In two, however, of the short central tentacles of this leaf the cells at their bases contained no aggregated matter and plenty of chlorophyll-grains. It is probable that if these tentacles had been examined two or three days earlier, an opposite state of things would have prevailed. In a third central tentacle from this same leaf there was still much aggregated matter in the basal cells; and here a few irregularly shaped chlorophyll-grains could be seen. In other tentacles from this same leaf, and from two other leaves which had been similarly treated, some of the aggregated masses had become granular, discoloured, and opaque; and this indicates that the solution had either been too strong, or that too large a quantity had been given.

Drops of a strong filtered solution of raw meat were now placed on 7 reddish leaves, the tentacles of which all became much inflected and their glands blackened. After 22½ hours they were syringed with water, and one leaf was cut off for examination. The contents of five short central tentacles from this leaf were aggregated down to their bases, and not a grain of chlorophyll could be seen. Some of the aggregated masses were almost white with a faint tinge of green, and were moving quickly. In the long exterior tentacles which had not at first been touched by the infusion (that is, not until they had become inflected), the aggregation had not as yet travelled down to the basal cells; and here the grains of chlorophyll were quite distinct. The infusion was too strong; for after five days one out of the six remaining leaves was dead; two others were much injured, with the outer tentacles killed, those on the disk, though immersed for a longer time, being still alive; the fourth leaf was considerably injured; the fifth and sixth looked fresh and vigorous, with their glands, now of a red colour, secreting freely. Five of the short central tentacles from one of these latter leaves were now (*i.e.* after the five days) examined: in three of them only a trace of aggregation was left, and plenty of chlorophyll-grains could be seen; in a fourth tentacle there were still some aggregated masses and a few chlorophyll-grains; in a fifth there were many aggregated masses and some fine granular matter, and here no chlorophyll-grains were distinguishable. There can

hardly be a doubt that in four out of these five tentacles the chlorophyll-grains had been reformed. On one of the much-injured leaves, in which the glands of the central tentacles were still opaque, the cells in their footstalks contained some aggregated and some brownish granular matter; and here minute globules were arranged along the walls of the cells in the places where chlorophyll-grains ought to have stood; but whether these were remnants which had never wholly disappeared or new grains reforming could not be ascertained.

Drops of a weaker infusion of raw meat were next placed on seven reddish leaves, which were all greatly acted on; but the infusion was still rather too strong. In from 24 to 25 hours afterwards all the leaves were well syringed; and small pieces having been cut off two of them, several of the short central tentacles were examined. In one of these leaves a very few chlorophyll-grains could be seen in some few cells in one of the tentacles which had not undergone so much aggregation as the others. In the piece from the second leaf not a single chlorophyll-grain could be distinguished in any of the short central tentacles. The sections were then immersed in alcohol, and in a few minutes all the aggregated masses were broken up into very fine granular matter; but no chlorophyll-grains could be seen, except in the one tentacle above mentioned. In three days after the drops had been first given, four of the leaves (including one of those from which a small piece had been cut off) looked vigorous, and were fully or almost fully expanded. The fifth leaf, from which a piece had likewise been cut off, appeared somewhat injured. The sixth had its tentacles still inflected and seemed much injured, and was apparently almost dead.

Four of the central tentacles on the vigorous leaf, from which a piece had been cut off, after 24 hours, were now (*i. e.* on the third day after the drop had been given) examined. In most of the basal cells of three of these tentacles only a trace of aggregation was left, and many chlorophyll-grains could be seen in them; but these were not so regular in shape or so regularly placed as are the normal grains; so that I presume they were in the act of reforming. Two basal cells in one of these tentacles still contained large quickly moving aggregated masses, and not a grain of chlorophyll could be distinguished in them. When this section was irrigated with the solution of iodine, the aggregated masses in the two just-mentioned cells instantly broke up

into brownish granular matter, and the irregular and, as I supposed, just reformed chlorophyll-grains in the adjoining cells ran together and became confluent, forming narrow rims along the walls.

After intervals of 4, 6, and 8 days from the time when the drops were given, 15 central tentacles on three of the leaves were examined; and in all of these tentacles, excepting one in which there was still much aggregated matter, chlorophyll-grains could be seen. After 11 days one of the leaves, from which a small piece had been cut off after an interval of 24 hours, and in which most of the central tentacles then included no chlorophyll-grains, was now reexamined. The central tentacles appeared perfectly healthy and were secreting: in 8 out of 10 of them, the cells included chlorophyll-grains having the usual appearance; in the other two tentacles there was still much aggregated matter and no ordinary chlorophyll-grains, but some few irregularly shaped chlorophyll-grains. With respect to the second leaf, from which a small piece had been cut off, and in which the central tentacles did not then (*i. e.* after 24 hours) contain a single chlorophyll-grain, only a very few of the central tentacles now (*i. e.* after 11 days) appeared healthy; but in two of them, which appeared quite uninjured, there were innumerable perfect chlorophyll-grains in all the cells from the glands down to the base.

Considering the whole of the evidence here given, there can hardly be a doubt that with the leaves of *Drosera* as soon as the aggregated masses break up, and even before they are wholly redissolved, grains of chlorophyll are reformed.

Drosophyllum lusitanicum.—The footstalks of the tentacles are bright green, from the large number of chlorophyll-grains which they contain. Two leaves were immersed in a solution of carbonate of ammonia (4 to 1000) for 23 and 24 hours, and the cells of the footstalks now contained innumerable spheres, some much smaller and some much larger than the grains of chlorophyll, and other oddly shaped masses, more or less confluent, of translucent bright-yellow matter, which, when irrigated with alcohol, instantly broke up into fine granular matter. I looked in vain in several of these tentacles for grains of chlorophyll. Another leaf was immersed for only 16½ hours in a weaker solution of 2 to 1000; but this sufficed to produce an abundance of yellow translucent bodies, which were seen to change their forms greatly,

though slowly. In many, but not in all, of the cells of this leaf the grains of chlorophyll were still quite distinct. The several leaves were left both in the stronger and weaker solutions for 48 hours; and this caused the yellow spheres and masses to disintegrate into brownish granular matter. In this respect the aggregated masses in *Drosophyllum* differ from those in *Drosera* and *Dionæa*. Leaves were also left for 24 and 48 hours in an infusion of raw meat; but no yellow aggregated masses were thus produced, and the grains of chlorophyll remained perfectly distinct. This singular difference in the action of the infusion of raw meat on the tentacles, as compared with those of *Drosera*, may perhaps be accounted for by their serving in *Drosophyllum* almost exclusively for the secretion of the viscid fluid by which insects are captured—the power of digestion and of absorption being chiefly confined, as I have explained in my 'Insectivorous Plants' (pp. 332–342), to the minute sessile glands on the disks of the leaves.

As in the three foregoing genera the grains of chlorophyll tend to aggregate into moving masses under the long-continued influence of a weak solution of carbonate of ammonia, I thought that the grains would probably be similarly acted on in all insectivorous plants; but this did not prove to be the case. The immersion of leaves of the common *Pinguicula* in a solution of the ammonia and in an infusion of raw meat did not cause any aggregation of the chlorophyll-grains, though numerous transparent spheres were formed within the glandular hairs. Again, the immersion in carbonate of ammonia of pieces of young and old pitchers of a *Nepenthes* (garden hybrid variety) caused the appearance of innumerable more or less confluent spheres of various sizes in the glands on the inner surface of the pitcher and in the exterior epidermal cells. These were formed of translucent matter, either almost colourless or of a brown, orange, purple, or greenish tint; but the grains of chlorophyll were not acted on.

Sarracenia purpurea.—The pitchers of this plant are evidently adapted for catching and drowning insects; but whether they can digest them, or may have the power of absorbing matter from their decaying remains, is doubtful *. Many observations

* See an interesting account of the inner epidermal cells by A. Batalin, "Ueber die Function der Epidermis in den Schläuchen von *Sarracenia* &c." 1880. Reprinted from 'Acta Horti Petropolitani,' t. vii. (1880).

were made; but one case will suffice. A piece of a pitcher was left for 24 hours in a solution of 4 parts of the carbonate of ammonia to 1000 of water, and for 24 additional hours in a solution of 7 to 1000. In the cells of the parenchyma, especially in those close to the vascular bundles, there were many spheres and aggregated masses of bright orange transparent matter. Spheres of the same and of various other tints were present in the epidermal cells, more especially in those on the inner surface of the pitcher; and some of these spheres were of exactly the same pale greenish colour as the swollen chlorophyll-grains which were still present in some places, being often collected together into rounded masses. In many of the epidermal cells which contained spheres no chlorophyll-grains could be seen, though they were abundantly present in the epidermis of fresh leaves; and it is this fact which chiefly leads me to believe that the chlorophyll-grains sometimes become so completely fused together as to form spheres, being often blended with the aggregated and coloured cell-sap. When a solution of iodine was added to these sections, the pale-coloured spheres and irregularly shaped aggregated masses became bright orange, and they were sometimes sprinkled over with blue particles of starch. The iodine did not cause their immediate disintegration and disappearance, nor did alcohol or acetic acid. In this respect they differ from the recently aggregated masses in *Drosera*; though in this latter plant the older and more solid aggregated masses are not acted on by these reagents. Many of the cells contained green granular matter, formed either by the chlorophyll-grains having been mechanically smashed or by their disintegration; and acetic acid sometimes caused this granular matter to change instantly into the same orange tint as that of the aggregated masses.

The orange spheres and variously shaped masses were seen in many sections of pitchers which had been exposed for different lengths of time to solutions of the carbonate of different strengths; and in many of them swollen grains of chlorophyll had become more or less confluent. The original nature of the latter could be recognized by the sinuous outlines and greenish tint. They were not seen to change their shapes spontaneously; but this could not have been expected in sections. Portions of a pitcher left in distilled water for nearly three days did not exhibit a single orange sphere or aggregated mass; but there were some colourless oil-globules which were dissolved by alcohol;

and the chlorophyll-grains, though generally much swollen, were still distinct. It may therefore be concluded that in *Sarracenia* the chlorophyll-grains often undergo aggregation under the influence of carbonate of ammonia, but that they are less easily acted on than those of *Dionæa* and *Drosera*.

Leaves with Glandular Hairs and other Leaves.—I had formerly observed, as described in my 'Insectivorous Plants,' that the glandular hairs of some plants absorb carbonate of ammonia and animal matter, and that aggregation is thus caused in them. Consequently such leaves and others without hairs were immersed in solutions of carbonate of ammonia (4 and 7 to 1000) generally for 24 hours. No marked effect was produced on the chlorophyll-grains, excepting their occasional displacement, in the following cases (plants were selected almost by hazard, but which belong to different families):—first, of leaves not bearing many or any glandular hairs, namely those of *Brassica*, *Fumaria*, *Fuchsia*, *Robinia*, *Oxalis*, *Tropæolum*, *Euphorbia*, *Stapelia*, *Beta*, *Allium*, *Lemna*, a fern (*Nephrodium*), a *Marchantia*, and a moss. Nor were the grains acted on in two species of *Saxifraga* (except on one occasion, when they formed masses shaped like a horseshoe, presently to be described), nor in *Primula sinensis*—although the leaves of these three species are clothed with glandular hairs, which absorb carbonate of ammonia and undergo aggregation. Young leaves of *Dipsacus sylvestris* were immersed for 24 hours in a solution of 7 to 1000, and large yellowish highly refracting spheres were formed in the upper epidermic cells which do not include any chlorophyll-grains, and the grains were not at all aggregated in other parts of the leaf. When the sections were irrigated with acetic acid or with alcohol, the spheres in the epidermal cells disappeared quickly, in nearly the same manner as occurs with recently aggregated masses in the cells of *Drosera*.

Leaves of *Cyclamen persicum*, which bear hardly any glandular hairs, were left in a solution of 7 to 1000 for 43 hours, and this caused the chlorophyll-grains to collect into heaps; in some parts the grains retained their outlines distinct; but in other parts they formed perfectly homogeneous bright-green masses of the shape of a horseshoe. These were cleared by alcohol; and it was evident that the grains had become completely fused together. It is remarkable that many of the central cells near the vascular bundles contained spherical or oddly shaped confluent

globules of pale-blue transparent matter. In the preceding paper an analogous result from the action of carbonate of ammonia is described in the underground stems and rhizomes of *Mercurialis perennis*. The leaves were left for 24 additional hours in the solution, and now the horseshoe masses disappeared, being converted into pulpy matter. The immersion of the leaves of this *Cyclamen* in water for 47 hours caused the chlorophyll-grains to accumulate into heaps, as is known to follow from any injury there was hardly a trace of their confluence, and none of the pale-blue globules were present. Similar horseshoe masses were seen, but only on one occasion, in the leaves of *Nicotiana tabacum* after their immersion in the solution; and so it was with the stems of *Euphorbia Peplus*. Portions cut from a leaf of *Mirabilis Jalapa* were left for 16½ hours in solutions of 4 and of 7 to 1000, and the chlorophyll-grains in many of the cells became completely confluent, forming horseshoe masses or rings; and they were sufficiently solid to project when the cells were torn open. When these horseshoe masses and rings were irrigated with acetic acid, they became so transparent that even their outlines could hardly be distinguished. If in these plants, and more especially in *Cyclamen* and *Mirabilis*, the confluent chlorophyll-grains forming the horseshoe masses are still alive (and this is rendered probable by their bright-green colour, and in the former plant by their breaking up when left for an additional day in the solution, and in the latter plant by the action of acetic acid on them), we have in these cases a first step in the process which in some plants leads to the formation of spontaneously moving masses lying free in the cell-sap.

Pelargonium zonale.—The effects produced by the immersion of the leaves of this plant for 24 or 48 hours in solutions of 4 or 7 parts of carbonate of ammonia to 1000 of water are not a little perplexing. The leaves are clothed with glandular hairs, which absorb the ammonia and undergo aggregation. Moreover, numerous almost colourless, shining, translucent spheres generally, but not invariably, appear in most of the epidermal cells in which there are no grains of chlorophyll, and in the palisade-cells, in which they abound, and likewise in the parenchyma. The smaller spheres blend together, and thus form large ones. A solution of only 2 to 1000 sometimes sufficed to produce the spheres. Usually the spheres are not acted on by alcohol, but occasionally they were dissolved by it. If after immersion in

alcohol they are subjected to the iodine solution, they soon almost disappear; but this, again, does not invariably occur. Acetic acid always caused their rapid disappearance, and without any apparent effervescence, a slight granular residue being sometimes left; and this occurred with leaves which had been kept so long in the solution that they were dead. The acid dissolved, of course with effervescence, the crystalline balls of carbonate of lime which occupy many of the palisade-cells. When sulphuric ether was added, the smaller spheres of transparent matter disappeared in the course of a few minutes, while the larger ones became brownish and granular in their centres; but this granular matter disappeared after a time, empty transparent bag-like membranes being left. Traces of similar membranous envelopes could sometimes be detected after the administration of acetic acid. Caustic potash did not act quickly on the spheres, but sometimes caused them to swell up. I do not know what ought to be inferred from the action of these several reagents with respect to the nature of the spheres and aggregated masses in which I never saw any movement.

On two or three occasions the palisade-cells of leaves which had been immersed in the solutions, instead of containing large transparent spheres, were gorged with innumerable, often irregularly-shaped, more or less confluent globules, many of them being much smaller than the chlorophyll-grains. This occurred with a leaf which had been immersed for only 18½ hours in a solution of 4 to 1000. After sections of this leaf had been cleared with alcohol, it was irrigated with the solution of iodine, and the globules rapidly ran together or became confluent, forming irregular amorphous masses.

It was difficult to ascertain whether the chlorophyll-grains ever or often became blended with other matter, and thus aided in the formation of the transparent spheres. The difficulty was partly due to the grains being easily acted on by water. Thus, in some sections made and placed in water, and then cleared in alcohol, no grains could be distinguished; while they were distinct in sections of the same leaf which had not been wetted before being placed in alcohol. Many grains were also found in a disintegrated condition in uninjured leaves which had been kept for 47 hours in water. It may be here added that not a single sphere could be seen in these leaves; nor were they present in leaves slightly injured by being kept for 24 hours in a very weak

solution of osmic acid. Nor, again, in a leaf which had been immersed in an infusion of raw meat for 24 and for 50 hours; and in this leaf the chlorophyll-grains were still visible in many places, but were sometimes heaped together. Notwithstanding the difficulty of ascertaining the effects of carbonate of ammonia on the chlorophyll-grains, chiefly owing to the action of water on them, I am led to believe, from the gradations which could be followed, and from the absence of chlorophyll-grains in the cells in which one or two large spheres were present, that in the case of the palisade- and parenchyma-cells matter produced by the disintegration of the grains first aggregates, together with other matter derived from the cell-sap, into minute globules, and that these aggregate into the larger spheres. I will give a single instance:—A leaf was immersed for 22½ hours in a solution of the carbonate of 4 to 1000, and sections, after being cleared in alcohol, exhibited in many places distinct chlorophyll-grains, and in other places only very fine granular matter, and in a very few cells minute transparent globules. The leaf was left for 24 additional hours in the solution; and now sections cleared in alcohol exhibited numerous minute shining translucent globules, many of which were smaller than the few remaining chlorophyll-grains. There were also other much larger transparent spheres, more or less confluent, which, when irrigated with acetic acid, instantly disappeared.

A leaf was immersed in a solution of 4 parts of phosphate of ammonia to 1000 of water, and after 23 hours there was no trace of aggregation. It was left for 24½ additional hours in the solution; and now sections cleared in alcohol exhibited not only minute shining colourless globules, smaller than the few remaining chlorophyll-grains, but plenty of large spheres, more or less aggregated together; and in the cells containing such spheres no chlorophyll-grains could be seen. The spheres, both large and small, disappeared instantly when acetic acid was added, as in the case of those produced by the carbonate. It appears, therefore, that these two salts act in the same manner, but that the phosphate acts more slowly than the carbonate, as is likewise the case with *Drosera*. A leaf immersed for 45 hours in a solution of 2 parts of nitrate of ammonia to 1000 of water was a good deal infiltrated and darkened in colour; but no spheres were formed; some of the chlorophyll-grains had, however, become confluent while still adhering to the walls of the cells.

Spirogyra (*crassa*?).—When filaments of this alga were placed in a solution of carbonate of ammonia (4 to 1000), the cell-sap became in a few minutes cloudy from the formation of innumerable granules, and the green spiral chlorophyll-band soon began to contract. A filament was irrigated under a cover-glass at 11.10 A.M. (Oct. 4) with the solution; and by 11.25 the cell-sap had everywhere become granular: in two of the cells the pointed ends of the chlorophyll-band and the irregular lateral projections were retracted, so that these bands now appeared much smoother and blunter than before. In two neighbouring cells the bands had become converted into circular masses surrounding the nuclei.

At 12.50 two cells were selected for further observation: in one of them the original spiral band now formed a layer of nearly uniform thickness, except in three of the corners where there were rounded lumps, which adhered closely to the two transverse and to one of the longitudinal walls of the cell. By 4 P.M. the layer on the longitudinal wall had become in the middle so thin that it consisted of a mere thread, which at 4.15 broke and disappeared; the upper end (with reference to the observer) of the layer then rapidly contracted into a pear-shaped mass. The layer at the lower end of the cell had by this time assumed a dumb-bell shape, which, however, soon afterwards became cylindrical. At 7.10 P.M. the appearance of the cell was utterly different; for there were now at the upper end two ill-defined masses, and at the lower end two somewhat irregular balls of green matter connected together by a thin band. At 8 A.M. on the following morning there was a large oval mass lying obliquely across the upper end of the cell, with its two extremities connected by bands with two spheres in the lower corners.

The changes in the other cell, which was observed at the same time, were almost equally great. The spiral band was first converted into two layers lining the two transverse walls, and these were connected together by a sinuous longitudinal band. At 4 P.M. there was in one of the corners a large pear-shaped mass, which contracted while it was watched into an oval mass, and at the opposite corner a small dark-green sphere. By 7.10 P.M. there were two spherical masses and an oval one, which latter by the next morning formed a much elongated dark band; and instead of two there was now only a single separate sphere.

At this same time two adjoining cells included four and five oval or spherical chlorophyll-balls; but one cell still retained a spiral band. Alcohol and acetic acid produced only the same clarifying effect on these masses as in the case of ordinary chlorophyll-grains.

Filaments of this alga were left for 26 hours in a solution of only 1 part of the carbonate to 1000 of water; but this sufficed to cause some granular deposition in the cell-sap, and many of the cells included, instead of the spiral band, spherical or oval or pear-shaped masses (and in one instance a half-moon-shaped mass) connected together by the finest threads of green matter, one of which was seen to break, and the pear-shaped mass quickly became almost spherical. The changes of form and the movements of the chlorophyll-band in the foregoing several cases, under the influence of the ammonia solution, closely resemble in most respects those which may be seen within the tentacles of *Drosera*. The above weak solution seemed to be favourable to the health of the plants; for after six days' immersion they looked greener and more vigorous than other plants of the same lot which had been kept in plain water. The cell-sap still contained brownish granular matter, and many of the cells oval or spherical masses.

The brownish granular matter is always precipitated quickly; and when three young cells, which were as transparent as glass, were irrigated with a solution of 7 to 1000, the precipitation seemed to be instantaneous. After a time the granules are either deposited on the protoplasm lining the walls of the cells, or they collect into one or two spherical masses in the middle of the cell. These spheres apparently consist of a delicate membrane lined with granules and enclosing cell-sap. They distinctly lay within the spiral band of chlorophyll. Their appearance reminded me of the bag-like masses sometimes produced within the cells of dark-red leaves of *Drosera* when acted on by ammonia. In one instance the granules became collected into a spiral band. They were not acted on by alcohol, sulphuric ether, acetic acid, or a solution of iodine. Alcohol caused the protoplasm lining the walls to contract, by which means the granular matter and chlorophyll-bodies were all carried towards the centre of the cell.

Three other kinds of Conferva were immersed in a solution of the carbonate, and were casually observed. In the first, in which

the cell-walls were dotted over with chlorophyll-grains, there was at first some slight degree of aggregation, and then the grains all became disintegrated. In the second species, the filaments of which were extremely thin, the solution produced no effect. In a third the chlorophyll-bodies became aggregated into spheres. If the species in this family are difficult to distinguish, systematists might probably derive aid by observing the different actions of a solution of carbonate of ammonia on them.

Conclusion.—From the facts given in this paper we see that certain salts of ammonia, more especially the carbonate, quickly cause the cell-sap in various plants belonging to widely different groups to deposit granules apparently of the nature of protein. These sometimes become aggregated into rounded masses. The same salts and, in the case of *Drosera*, an infusion of raw meat tend to act on the chlorophyll-bodies, causing them in some few species to become completely fused together, either in union with the aggregated cell-sap or separately from it. Aggregation seems to be a vital process, as it does not occur in recently killed cells; and any thing which kills a cell causes the already aggregated masses instantly to disintegrate. These masses, moreover, display in some cases incessant movements. The process of aggregation is not rarely carried so far that the masses lose the power of movement; nor do they then readily disintegrate when subjected to any deadly influence. From these facts, from other considerations, and more especially from the action of carbonate of ammonia on the chlorophyll-bodies, I am led to believe that the aggregated masses include living protoplasm, to which their power of movement may be attributed. The most remarkable point in the whole phenomenon is, that with the Droseraceæ the most diverse stimuli (even a stimulus transmitted from a distant part of the leaf) induces the process of aggregation. The redissolution in the course of a few days of the solid aggregated masses and, especially, the regeneration of the chlorophyll-grains are likewise remarkable phenomena.

Notes on Recent Additions to the New-Zealand Flora. By Thomas Kirk, F.L.S.

[Read June 1, 1882.]

Capsella procumbens, *Fries.*—Hutchinsia procumbens, *Hook. f. Fl. Tasm.*—I have received specimens of this plant from Mr. D. Petrie, who collected them at Cape Whybrow and Forbury Head, Otago. Those from the last-named locality are small, scarcely an inch in height; and those from Cape Whybrow do not attain the usual size of European and Australian specimens, the largest not exceeding 3 inches. The leaves are entire or deeply toothed in all my specimens, never pinnatifid, and the flowers equal the calyx. The racemes are elongated and open in fruit, and the pod is narrowed at both ends.

It will doubtless be found in other localities; but, from its small size, may easily be overlooked.

Myriophyllum verrucosum, *Lindl.*—I collected this plant in ponds between Tauranga Harbour and the sea, but am not aware of its occurrence in any other part of the colony. It differs from *M. elatinoides* and *M. variæfolium* in its more slender habit, and in having all the floral leaves pinnatifid; the flowers are small, with minute sepals, and the carpels are tuberculated.

Cotula integrifolia, *Hook. f.*—This plant is not unfrequent in situations where water has stagnated, but which have become dry on the approach of summer. It varies greatly in stature and luxuriance; but a complete series may be traced from minute one-flowered forms with entire leaves, the plant less than 1 inch in height, to the most luxuriant forms of *C. coronopifolia*. It can only be regarded as a transitory state of that species, and cannot take rank even as a trivial variety. British botanists are familiar with a similar state of *Bidens cernua*.

Mentha australis, *R. Br.*—This species, remarkable even amongst its congeners for its powerful odour, occurs in great abundance in the Wairarapa, especially about Carterton; but I fear that it must be regarded as an introduced plant. I observed it more or less continuously for three or four miles along the road, especially plentiful in ditches, but occurring also in the adjacent forest.

It is an erect herb, with pale-green leaves and acutely-angled stems; the flowers are produced in great abundance in axillary false whorls, which may be pedicellate or sessile; calyx pubes-

cent or hairy, with long subulate teeth; the corolla-tube is small, scarcely exceeding the calyx in length, the mouth deeply two-lobed.

Our plant fills the ditches by the roadside, where it attains the height of over 2 feet. In moist places in the adjacent forest it is much smaller. It is called "turpentine" by the settlers.

POLYGONUM PROSTRATUM, *R. Br.*—A much-branched, prostrate, suffruticose plant, the branches rooting from beneath, in the present specimens 6″–10″ high; the young branches and leaves sparingly clothed with rather long white hairs. Leaves lanceolate, narrowed into a short petiole 1″ long; stipules sheathing, ciliate. Spikes axillary or terminating short branchlets, sessile or shortly pedunculate, ½″ long. Perianth small, becoming enlarged after flowering. Stamens 6. Nut convex, black, faintly reticulated. In several places by the Wairarapa Lake (*H. B. Kirk*).

JUNCUS PAUCIFLORUS, *R. Br.* (not of *T. Kirk*).—Although somewhat local, this species occurs throughout the colony, and is abundant in Stewart Island; it is generally known to New-Zealand botanists as *Juncus communis*, var. *hexagonus*; it is, however, distinct from that species, although of similar habit.

The panicle is lax, consisting of a few slender branches; flowers few in number and small; perianth-segments acute; stamens 6; capsule ovoid, faintly angled. The culms are usually slender and the sheaths at the base very short. It appears to have been collected in New Zealand by Banks and Solander.

JUNCUS BREVIFOLIUS, *T. Kirk.*—J. pauciflorus, *T. Kirk* (not of *R. Brown*)—In the 'Transactions of the New-Zealand Institute,' vol. ix. p. 551, I described this small species under the name of *J. pauciflorus*; but as that name had been applied by Brown to the plant mentioned above, I propose to term my plant *Juncus brevifolius.*

It is distinguished from all New-Zealand species by its rosulate leaves, slender, naked, erect culms, and sessile flowers. At present it has only been observed in the Broken-River basin, Southern Alps, alt. 2000 feet.

CENTROLEPIS MONOGYNA, *Benth.* — Alepyrum monogynum, *Hook. f.*—This moss-like plant occurs in swampy places at an elevation of 3000 feet in Arthur's Pass, where it was observed by the writer in 1877, when specimens were distributed under the MS. name of *Alepyrum viride.*

It forms large patches scarcely ½″ in height when in flower.

Leaves deep green, subulate, acute, dilated into a broad membranous base, with a few short hairs at the back. Bracts subopposite, narrow. Flowers two, each invested by a semitransparent scale which nearly equals the bract, and consisting of a single stamen and a single carpel.

HIEROCHLOË ALPINA, *Rœm. & Schultes*, var. SUBMUTICA.—H. submutica, *F. Mueller.*—Danthonia Buchanani, *J. Buchanan, Manual of Indigenous Grasses of New Zealand*, p. 87, pl. xxxv., not of *Hook. f.*—This form is intermediate between *H. redolens* and *H. alpina*; but is most closely related to the latter. The New-Zealand plant agrees with that of Victoria in habit, and especially in the lower glumes being scarcely ciliated, but the awns are usually longer. The panicle is more open than in *H. alpina*; the branches are longer and extremely slender, distant, usually drooping; spikelets 3–6; leaves broad, flat.

Common in mountain districts, especially on the west coast of the South Island.

In 'Flora Australiensis' Mr. Bentham unites *H. redolens* and *H. alpina*; and considers our plant a connecting form which may possibly prove worthy of specific rank.

I fully agree with Mr. Buchanan in considering *H. alpina* distinct from the European *H. borealis*; but cannot understand his having mistaken our plant for a *Danthonia*, especially for *D. Buchanani*, which, independently of its generic and sectional distinctive characters, is described as having a short contracted panicle and filiform leaves.

STIPA MICRANTHA, *R. Br.*—Streptachne ramosissima, *Trin. & Rup.*—I have previously recorded the occurrence of this plant in the colony, and now add that it was originally discovered by Mr. W. T. L. Travers near Fox Hill in the Nelson district. Recently it has been found in great abundance in the Takaka ranges, Nelson, by the Rev. F. D. Spencer, who informs me that its culms attain several feet in length.

It occurs in small quantity on the Miramar peninsula, near Wellington, and must be regarded as a relic of the indigenous vegetation of that locality, although I formerly considered it to be naturalized only. The culms are from 2 to 5 feet long, suberect or prostrate, much branched; the branches sometimes abbreviated, and forming rounded bunches at the nodes, sometimes long and spreading. Panicle from 6″ to 2′ in length; branches numerous, capillary; spikelets small; outer glumes

narrow, nearly equal. Flowering-glume shortly stipitate, entire; awn ½″ long, articulated on the glume. Palea less than half as long as the glume. The habit is that of *Microlæna polynoda*; but the plant is much larger.

STIPA SETACEA, *R. Br.*—S. Petriei, *Buchanan*, *Manual of Indigenous Grasses of N. Z.* p. 171, pl. xvii². f. 2.—Mr. Buchanan's *Stipa Petriei* must be referred to this species, which has a wide distribution in Australia. None of the specimens kindly sent me by Mr. Petrie have the outer glumes so unequal as represented in Mr. Buchanan's plate.

DAVALLIA DUBIA, *R. Br.*—In vol. xii. of 'Transactions of the New-Zealand Institute' this fern is recorded by Mr. Armstrong, jun., as a native of New Zealand, but erroneously, as it has not been observed in the colony. Specimens of *Hypolepis millæfolium* with the pinnules less divided than usual appear to have been mistaken for it.

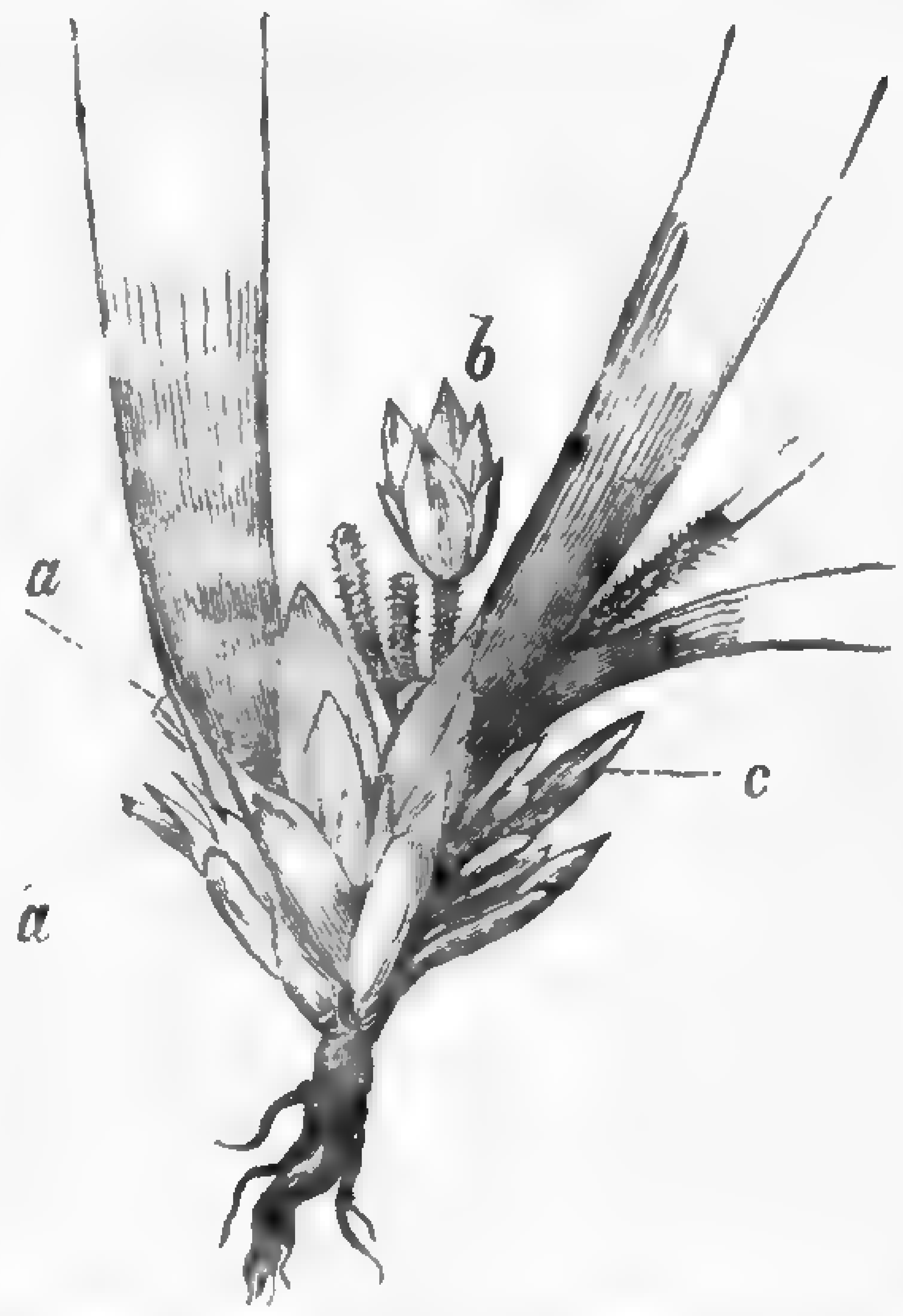
On the Occurrence of Single Florets on the Rootstock of *Catananche lutea*. By B. DAYDON JACKSON, Sec. L.S.

[Read May 4, 1882.]

IN a letter which M. Battandier, of Mustapha in Algeria, sent to the President last spring, he enclosed a specimen of *Catananche lutea*, to show that this Composita, in addition to its normal ligulate florets in the capitulum, produces also florets which are almost entirely concealed amongst the scales of the rootstock at the base of the plant. They are not cleistogamic; and the fruits resulting are twice the size of the normal achenia in the capitula. The individuals being often cut when making hay, or browsed close by cattle, these hidden florets are of signal service, by reproducing the plant when the usual method is frustrated.

Since the receipt of M. Battandier's letter, I have examined the whole of the specimens in the Kew and British Museum herbaria; and have found these florets constantly present, mostly in great abundance in this species, but have not detected them in the remaining species of this small genus. So constantly are they to be found, that they may be taken as the most obvious character of the species in the dried state. The accompanying figure shows the base of a specimen—*a, a* being two of these florets protruding their styles, with the stigmata yet unexpanded; *c* shows a floret less advanced; *b* is a floret apparently inter-

mediate in character between these root-florets and the normal capitula.



Rootstock-florets of *Catananche lutea.*

This singular phenomenon is not confined to the plant in question. The base of *Scirpus arenarius*, Boeckl., has thick clusters of flowers, quite hidden when growing in the sand. Similar instances have been noticed by Dr. Asa Gray in *Scirpus supinus*, L., a small form of which in the Kew Herbarium, from S. Africa, shows them plainly; but none of the European specimens of the typical form which have come under my notice display them. A specimen of *Eritrichium capituliflorum*, Clos, collected in Chili in 1873 by Mr. E. C. Reed, in the Kew Herbarium, shows carpels at the base of the stem, which are seemingly perfect. Subterranean flowers have also been detected in *Epiphegus virginiana*, as mentioned by the Rev. G. Henslow in 'Trans. Linn. Soc.' ser. 2, Botany, i. p. 373.

[Since writing the foregoing, I have accidentally found that Salisbury knew of these root-florets. In his 'Prodromus' (1796), p. 183, he writes of this species:—"Floret sæpe singulariter juxta radicem."]

Note on two Himalayan Ferns erroneously treated in the "Ferns of Northern India." By C. B. Clarke, F.R.S., F.L.S.

[Read June 1, 1882.]

H. C. Levinge, Secretary to the Government in the Public Works Department, one of the most accomplished pteridologists now in India, has written to me several letters regarding my paper on the Ferns of Northern India, published in the Transactions of this Society for 1880; he has also transmitted to me at Kew fine series of examples of several of the critical species; and has convinced me that several of the species I have admitted are only varieties, while many of the species reduced by me, especially among the compound Athyriums, would be better retained as

species. But with regard to two ferns treated by me in "The Ferns of Northern India," Mr. Levinge has shown me distinct errors which I desire to take an early opportunity of correcting. It must be understood that these corrections are entirely due to my friend H. C. Levinge; but as they have formed the subject of several letters, he has authorized me to write them out in a form better fitted for publication.

Col. Beddome, in his 'Ferns Brit. Ind.' t. 333, figured a new Himalayan fern as *Lastrea pulvinulifera*. Beddome at the same time communicated a type specimen to Kew. This sheet is here (exhibited at the Meeting), with only one ticket on it, marked n. 99, and named in Beddome's hand. But this sheet has now mounted on it two ferns which are totally distinct: the upper is the fern described in my paper as *Nephrodium sparsum* var. *squamulosa*; the other is the fern taken up by Baker as *Nephrodium pulvinuliferum*, and so called in my paper on the Ferns of Northern India. Mr. Baker is strongly of opinion that the two ferns were sent him as one species, and that the figure, Bedd. 'Ferns Brit. Ind.' t. 333, is compounded out of the two, showing the cushion-like caudex of *N. sparsum* var. *squamulosa*, united to the long-bristle-hairy rhachises of *N. pulvinuliferum*, Baker. Col. Beddome, on the other hand, maintains that he sent Mr. Baker only one fern, viz. the *N. sparsum* var. *squamulosa*, and that his figure represents that only, the hairs on the rhachises being only a slight artistic exaggeration of the black scales which occur in that species. Col. Beddome maintains that the lower piece, the *N. pulvinuliferum*, Baker, was mixed on the sheet in the Kew pasting-down, and that it is a fern he never saw in his life till he saw it at Kew as *N. pulvinuliferum*. I must leave Col. Beddome and Mr. Baker to settle this between them. Perhaps it is not capable of settlement; and, if so, the future naming of these two ferns must be determined outside the ordinary rules of nomenclature. I have stated in my paper that *N. pulvinuliferum*, Baker, is also known as *N. Buchanani*, which is correct. I therefore now suggest that this fern be called, both in India and Africa, *N. Buchanani*, and that the name "*pulvinuliferum*" be applied (whether as species or variety) to the fern called in my paper *N. sparsum* var. *squamulosa*; that is, the fern which bears a cushion (*pulvinus*) at the caudex, which *N. pulvinuliferum*, Baker, does not; and that is the fern which Beddome himself says was the only one intended by him as *pulvinulifera*.

The other fern which has been confounded by me in my Revision is the one there named *Davallia dareæformis*, Levinge MS., which is made up out of the two ferns previously known as *Acrophorus Hookeri*, Moore, and *Polypodium dareæforme*, Hook. I have thrown these two into one by misunderstanding Levinge's MS. note at Kew. Levinge noted that *P. dareæforme*, Hook., was a *Davallia*; and I erroneously assumed that he meant it to be the same plant as *Acrophorus Hookeri.* The two are extremely alike, as may be seen from the typical sheets of them here (type sheets exhibited at the Meeting); but the scales on the rhizome sufficiently distinguish them specifically. Col. Beddome indeed still maintains that they are generically distinct; *i. e.* that there is a small scale over the young sorus in *Acrophorus Hookeri*, and that there is absolutely no such scale in *Polypodium dareæforme.* I certainly think that the orthodox school of English pteridologists pay far too exclusive attention to this small scale as a generic character throughout the whole of their arrangement, and that Mettenius and Mr. J. Smith have better indicated the true affinities of ferns by laying more stress on the articulation of the caudex and the venation. The amalgamated *D. dareæformis*, Levinge, of my paper must be split in any case into two species, viz.:—

D. DAREÆFORMIS, *Levinge*,=Polypodium dareæforme, *Hook. 2nd Cent. Ferns*, t. 24.—Acrophorus Hookeri, *Bedd. Ferns Brit. Ind.* t. 95.—Gymnogrammitis, *Griff. Ic. Pl. As.* t. 129. fig. 1.

D. CLARKII, *Hook. & Baker, Syn. Fil.* 91, = Acrophorus Hookeri, *Moore, Ind. Fil.* ii. 2, *not of Bedd.*

On *Dyera*, a new Genus of Rubber-producing Plants belonging to the Natural Order Apocynaceæ, from the Malayan Archipelago. By Sir J. D. HOOKER, F.R.S., Vice-Pres. L.S.

[Read June 15, 1882.]

IN the course of studying the Apocynaceæ for the 'Flora of British India' my attention was drawn to two Malayan Rubber-producing plants which constitute a new genus of the Order. Of these, one, from Malacca, had been correctly referred by Mr. Dyer to *Alstonia? costulata*, Miquel (Flor. Ind. Bat. Suppl. 556), a Sumatran plant, described from leaves only, of which an authentically

named specimen was communicated by its author to Sir W. Hooker, and is preserved in the Kew Herbarium. This species is mentioned amongst the Rubbers enumerated in the Kew Reports for 1878 (p. 39) and 1880 (p. 47), as yielding the gutta-jelutong. The other, a very closely allied and apparently undescribed species, is a native of Borneo, and was sent first by Mr. Low as the Gutta Jelutong of that island, and subsequently from the Singapore Botanic Gardens by Mr. Burbidge under the same name. Fortunately flowering individuals of both these species have been collected. Of the Malacca one first by Griffith (who is indeed the discoverer of that one, and hence of the genus), and who communicated specimens to Dr. Wight, then resident in the Madras Presidency, and to Dr. Gardner, when that botanist was Superintendent of the Ceylon Botanic Gardens, and both of which are preserved at Kew; secondly, by that indefatigable Indian botanist Dr. Maingay, whose specimens in flower and young fruit are accompanied by MS. notes; and, lastly, by Mr. Murton, late Superintendent of the Singapore Botanical Gardens, who has communicated to the museum at Kew leaves and old fruits, from which unfortunately the seeds have escaped. Of the Bornean plant, the only flowering specimens I have seen are from Dr. Beccari, and are the No. 3570 of his splendid herbaria. But besides the leafy one above mentioned from Mr. Low and the cultivated ones procured by Mr. Burbidge, there is in the herbarium one from Mr. Lobb collected in 1856, or thereabouts, in Borneo.

For this genus I propose the name of *Dyera*, after Mr. Thiselton Dyer, F.R.S., the Assistant Director of Kew, to whom I am indebted for the discrimination of the Rubber-yielding plants enumerated in the Kew Reports, and whose paper on the subject is now, I believe, to be presented to the Society. It nearest affinity is no doubt with *Alstonia*, from which it differs conspicuously in the sessile stigma, a character rare in the Order, and in the singular fruit. It further differs from that genus in the extraordinary minuteness of the flowers, which are scarcely $\frac{1}{18}$ of an inch in length, whilst the ovules have a diameter (as taken from dried specimens after saturation with warm water) of only $\frac{1}{200}$ to $\frac{1}{300}$ of an inch. These latter minute organs are succeeded by fruits of unusually large dimensions for the Order.

Dyera, gen. nov.

Char. gen. Calyx 5-fidus, eglandulosus v. glandulis parvis ad basin loborum. Corolla hypocrateriformis, tubo cylindraceo calycem paullo excedente vix ad stamina dilatato; glandulis squamisve inter stamina ad basin filamentorum instructo, fauce esquamata; lobi 5, contorti, sinistrorsum obtegentes, vix torti. Stamina infra medium tubi inserta, inclusa, filamentis brevibus; antheræ liberæ, oblongo-ovoideæ, crassiusculæ, loculis infra medium connectivi crassi apice obtusi positis inappendiculatis basi obtusis. Discus obscurus, annularis, v. 0. Ovarium integrum, late obconico-hemisphæricum, vertice obtusum, glanduloso-puberulum, 2-loculare; stigma obpyriforme, sessile, 2-partitum, lobis sibimet adpressis; ovula in loculis numerosa, placentis loculo intrusis multiseriatim conferta. Folliculi 2, crassi, elongati, basi confluentes et reflexi, dein rectiusculi, obtusi, polyspermi. Semina compressa, alata, * * *.—Arbores elatæ, ramulis crassis verticillatis, gummem elasticam copiosam scatentes. Folia verticillata, quovis verticillo 6–9, crasse coriacea, obovata v. oblonga, obtusa, subtus pallida, nervis crassis patentibus, petiolo longiusculo. Flores minuti, in cymas axillares et subterminales longe pedunculatas umbellatim dispositi, minute bracteati.

1. Dyera costulata, *nob.* Foliis oblongis utrinque rotundatis.—Alstonia? costulata, *Miquel, Fl. Ind. Bat. Suppl.* 556.

Hab. Sumatra, *Teysmann*; Malacca, *Griffith*, *Maingay* (*Kew distrib.* 2573).

2. D. Lowii, *nob.* Foliis obovatis basi in petiolum angustatis.

Hab. Borneo, *Low*, *Beccari*; Sarawak, *Thos. Lobb.*

On a Collection of Ferns made by the Rev. R. B. Comins in the Solomon Islands. By J. G. Baker, F.R.S., F.L.S.

[Read June 15, 1882.]

I have just been favoured with an opportunity of examining a collection of ferns made by the Rev. R. B. Comins in the Solomon Archipelago, collected mainly in San Cristoval, the southern island of the group, and the adjacent islet of Contrarietes. It contains altogether upwards of sixty species of ferns, Lycopods, and Selaginellaceæ, of which the following are of special interest, the remainder being widely-spread Polynesian and tropical Asiatic types.

Davallia Denhami, *Hook.*

LOMARIA VULCANICA, *Blume*?

48*. ASPLENIUM (§ EUASPLENIUM) LUDENS, n. sp.

Stipite elongato minute paleaceo, frondibus oblongo-lanceolatis simpliciter pinnatis papyraceis glabris, pinnis lanceolatis acuminatis serratis brevissime petiolatis basi subæqualiter rotundatis vel deltoideis, venis crebris patulis subsimplicibus, soris linearibus medianis parallelis.

Caudex decumbent. Paleæ minute, brown, lanceolate, membranous. Stipe half a foot or more long, green, minutely paleaceous, as is also the axis of the lamina. Frond in the fully developed form oblong, simply pinnate, a foot or more long, 6–8 inches broad, membranous in texture, bright green and glabrous on both surfaces. Pinnæ contiguous, nearly sessile, lanceolate acuminate, finely serrated, the largest 4–5 in. long, $\frac{5}{8}$–$\frac{3}{4}$ in. broad, nearly equal (broadly deltoid or rather rounded) at the base, the lower ones not at all dwarfed. Veins fine, close, distinct, simple or forked, spreading from the costa at an angle of about 80°. Sori parallel, running along the veins from the costa more than halfway to the midrib, not more than $\frac{1}{6}$ in. long. Involucre narrow, glabrous.

A near ally of *A. multilineatum*, Hook., and, like that, the young fronds run into bipinnate dareoid forms, with small linear secondary segments. In *A. multilineatum* the veins are closer, and the sori run along them regularly from end to end.

ASPLENIUM UMBROSUM, var. CRISTOVALENSE, n. var.

Closely allied to *A. assimile* of Norfolk Island; but the tertiary segments broader in proportion to their length, inæquilaterally ovate-deltoid; the largest $\frac{1}{4}$–$\frac{1}{3}$ in. long., $\frac{1}{6}$ in. broad, obtuse deeply pinnatifid. The sori begin at the costa and run about halfway up the vein, and are occasionally diplazioid. The Indian botanists who work at ferns seem all to think that *assimile* ought to be separated as a good species from *umbrosum*. Probably the best plan would be to keep that name for a species of which the Indian, Norfolk-Island, and San Cristoval plants should be regarded as three distinct geographical races: 1, Norfolk-Island type; 2, *indicum*, figured Beddome, Fil. Brit. Ind. t. 294; and 3, *sancristovalense*.

ASPLENIUM (§ DAREA) OBTUSILOBUM, *Hook.*

ASPLENIUM (§ DIPLAZIUM) BRACKENRIDGEI, *Baker*.

ASPIDIUM (§ CYCLOPELTIS) SEMICORDATUM, var. BIAURICULATUM, n. var.

Pinnæ with a large rounded auricle on each side at the base, imbricated over the rhachis, and sori forming only a single row nearer the margin than the midrib.

Gathered previously in San Cristoval by Milne.

NEPHRODIUM (§ LASTREA) HARVEYI, *Baker.*

NEPHRODIUM (§ EUNEPHRODIUM) TRUNCATUM, *Presl.*

NEPHRODIUM (§ EUNEPHRODIUM) AMBOINENSE, var. SUBGLANDULOSUM, n. var.

A form intermediate between *N. amboinense* and *glandulosum*. The sterile pinnæ rather broader than in typical *amboinense* and shallowly lobed; the fertile pinnæ entire, not more than $\frac{1}{2}$ in. broad at the base, narrowed gradually to the very acuminate apex; the main veins $\frac{1}{8}$ in. apart, the veinlets simple, erecto-patent, 4–5-jugate, with a small median sorus on each of them.

213*. NEPHRODIUM (§ SAGENIA) HEDERÆFOLIUM, n. sp.

Stipite nudo castaneo, frondibus cordato-deltoideis profunde pinnatifidis parvis papyraceis glabris, segmentis primariis subtrijugis, superioribus parvis integris, infimis multo majoribus inæquilateralibus latere inferiori profunde lobatis, venis præter primarias rectas in areolas copiosas parvas anastomosantibus, soris magnis subregulariter seriatis.

Stipe 6–9 in. long, naked, slender, castaneous. Frond cordate-deltoid, simple, $\frac{1}{2}$ ft. long and broad, palmately lobed at the base within a short distance of the rhachis, membranous, green and glabrous on both surfaces; the lower lobes much the largest, deeply pinnatifid on the lower side, with oblong segments; the central segments of the main frond erecto-patent, oblong-lanceolate, subacute, reaching about halfway down; the other lobes very short. Areolæ very small and very distinct, with copious free included veinlets. Sori few, large, arranged in rows near the main veins. Involucre large, reniform, glabrous, persistent.

Most like *Aspidium platanifolium* in the size and outline of the frond, with sori and involucre as in *Nephrodium* (§ *Sagenia*) *Pica*.

217*. NEPHRODIUM (§ SAGENIA) MACROSORUM, n. sp.

Stipite nudo castaneo, frondibus deltoideis pinnatis papyraceis glabris, pinnis productis circiter trijugis lanceolatis crenatis vel pinnatifidis segmentis oblongis, pinnis centralibus basi conspicue decurrentibus, frondis apice profunde pinnatifidis, venis primariis rectis, reliquis in areolas parvas copiosas anastomosantibus, soris magnis in seriebus regularibus prope venas primarias dispositis.

Stipe naked, castaneous. Frond deltoid, simply pinnate, about

a foot long and broad, bright green and glabrous on both surfaces. Distinct pinnæ not more than 4-jugate, erecto-patent, all (except the lowest) joined by their conspicuously decurrent bases. Lowest pair of pinnæ largest, lanceolate, 8–9 in. long, $1\frac{1}{4}$–$1\frac{1}{2}$ in. broad, lobed about halfway down to their midribs in the middle, with obtuse erecto-patent ovate-oblong segments. Main veins erecto-patent, $\frac{1}{4}$–$\frac{1}{3}$ in. apart, straight and distinct from midrib to margin. Sori large, orbicular, in regular rows near the main veins.

This comes nearest the common Polynesian *N. decurrens*; but the wing to the rhachis does not reach down to the basal pinnæ or run down the stipe. The pinnæ are narrower and deeply pinnatifid, and their main veins more distant.

POLYPODIUM (§ PHYMATODES) AFFINE, *Blume.*

POLYPODIUM (§ PHYMATODES) NIGRESCENS, *Blume.*

POLYPODIUM (§ PHYMATODES) LINGUÆFORME, *Mett.*

11*. GYMNOGRAMME (§ LEPTOGRAMME) COMINSII, n. sp.

Fruticosa, frondibus amplis deltoideis tripinnatifidis, pinnis oblongo-lanceolatis, pinnulis lanceolatis acuminatis sessilibus, segmentis tertiariis oblongis contiguis serratis, venis pinnatis, venulis simplicibus 6–7-jugis, soris oblongis parallelis intramarginalibus.

Frond ample, tripinnatifid, moderately firm in texture, green and glabrous on both surfaces, the rhachises naked. Pinnæ oblong-lanceolate, the lower 1–$1\frac{1}{2}$ ft. long, 6–8 in. broad. Pinnules sessile, patent, lanceolate, acuminate, cut down within a short distance of the midrib into contiguous oblong distinctly serrated tertiary segments $\frac{1}{8}$ in. broad. Veins pinnate in the tertiary segments, with 6–7-jugate simple distinct ascending veinlets. Sori oblong, parallel, beginning at the midrib, but ending a space from the margin.

The most interesting novelty in the collection, with the habit precisely of the large Diplazioid Asplenia *A. maximum* of the Old World (with which, no doubt, *A. latifolium* must be joined), and *A. radicans*, Schk. (*A. dubium*, Mett.), of America.

GYMNOGRAMME (§ SYNGRAMME) QUINATA, *Hook.*

Fronds trifoliate, and one specimen quite simple, but yet completely soriferous, and closely resembling *G. Wallichii.*

ANTROPHYUM SEMICOSTATUM, *Blume.*

ACROSTICHUM (§ CŒNOPTERIS) CERVINUM, *Sw.*

ACROSTICHUM (§ GYMNOPTERIS) FLAGELLIFERUM, *Wall.*

ACROSTICHUM (§ GYMNOPTERIS) REPANDUM, *Blume.*

ACROSTICHUM (§ CHRYSODIUM) POLYPHYLLUM, *Hook.*

LYGODIUM TRIFURCATUM, *Baker.*

LYGODIUM DICHOTOMUM, *Sw.* Very fine specimen.

PSILOTUM COMPLANATUM, *Sw.*

SELAGINELLA RADICATA, *Spring.*

On two new, and one wrongly referred, Cyrtandreæ. By H. O. FORBES. (Communicated by W. T. THISELTON DYER, F.R.S., F.L.S.)

[Read June 15, 1882.]

BOEA TREUBII, *Forbes.*—Suffruticosa, caule usque ad 3–4 pedes alto, pallide cinnamomeo-tomentoso; foliis oppositis, breviter petiolatis, elongato-lanceolatis, supra glabratis, subtus cinnamomeo-tomentosis; pedunculis multifloris, in paniculam terminalem abeuntibus; corolla in diam. 0·20–0·25 metr. purpurascenti-cærulea.

Folia acuminata, serrulata, undulata; petioli connati, basi dilatati, caulem amplectentes. Bracteæ inferiores, foliis similes, sed minores. Calyx 5-partitus; laciniis lanceolatis, acuminatis tomentosis. Corolla oblique campanulata, tubus calyce brevior; limbus bilabiatus, lobis obovato-rotundatis. Stamina 2 perfecta, corolla multo breviora, 2–3 rudimentaria; filamenta arcuata; antheræ magnæ, cordato-oblongæ, reniformes, aurantiacæ, apicibus cohærentes, loculis subrectis confluentibus. Capsula ovoideo-cylindrica, bivalvis, valvis etiam in capsula perjuveni spiraliter dextrorsum tortis, loculicide dehiscens; placentæ membranaceæ, 2-fidæ, revolutæ, semina minuta integentes.

Sumatra, in monte calcareo Karangnata, prope Napal Litjin, in provincia Palembang, alt. 1000 ped.

I found this singularly beautiful and graceful plant in full flower in November 1881, first near the village of Napal Litjin, 580 feet above the sea; but in profusion on the large disrupted calcareous blocks near the summit of the peak of Karangnata, in company with magnificent spike-bearing Cœlogynes and pink-fruited Melastomaceæ. I am not satisfied that *Boea Treubii* may not form a new genus; it differs from *Boea* in its large size and

entire stigma. The specific name is given in honour of Dr. Treub, Director of the Botanic Gardens, Buitenzorg.

Didymocarpus Schefferi, *Forbes.*—Suffruticosa, erecta, caule brevi pallide cinnamomeo-tomentoso; foliis oppositis, breviter petiolatis, late lanceolatis, crenulatis, subtus arachnoideo-tomentosis; pedunculis longis, corymbis paniculatis; corolla parva oblique campanulata; capsula lineari, valvis haud tortis.—Boea borneensis, *Scheffer, MS. in Herb. Hort. Bogor.*

Folia acuminata, supra cinnamomeo-tomentosa aut glabrata; petioli basi dilatati, caulem amplectentes. Pedunculi tomentosi; pedicelli bracteæque decidue flocculosi, mox glabri. Sepala 5, parva, lanceolata, glabrata. Stamina perfecta 2; antheræ magnæ, late cordato-reniformes, apicibus cohærentes, loculis divergentibus apice confluentibus. Capsula ·04 metr. longa, teres, loculicide in altero latere dehiscens, subfollicularis.

Borneo, Pœloe Pandan; legit Teysmann, n. 8430.

The specific name is given in memory of Dr. Scheffer, late Director of the Botanic Gardens, Buitenzorg.

Didymocarpus minahassæ, *Forbes.*—Suffruticosa, caule subprocumbente, tomentoso; foliis oppositis, longe petiolatis, cordato-ovatis, integris, subtus pallidissime cinnamomeo-tomentosis; scapis axillaribus, elongatis, cymis 2–3chotomis; corolla suboblique campanulata, in diam. 17 mm.; capsula lineari, valvis haud tortis.—Baea minahassæ, *Teys. et Binn. in Batav. Tijdsschr.* xxv. p. 17.

Scapi tomentosi; cymæ glabratæ. Corollæ tubus brevis, limbus 2-labiatus, lobis 5 rotundatis. Stamina perfecta 2; antheræ magnæ, late cordato-reniformes, apicibus cohærentes, loculis divergentibus apice confluentibus. Capsula in altero latere cilius dehiscens, follicularis aut postremo 2-valvis.

Celebes, in provincia Minahassa, in regione Likœpang; legit Teysmann; et prope Menado, Hort. Bogor. n. 5262.

The note in C. B. Clarke, 'Comm. et Cyrt. Beng.' p. 116, that "*Boea minahassæ*, Teys. et Binn., hardly differs from *Boea flocculosa* except by its glabrate pedicels and bracts," is erroneous. Mr. C. B. Clarke must have assumed, without seeing any example, that Teys. et Binn. were right as to the genus of their plant.

Researches on the Life-history of *Hemileia vastatrix*, the Fungus of the "Coffee-leaf Disease."

By H. Marshall Ward, B.A., Fellow of Owens College, Manchester, late on special duty as Cryptogamist to the Government of Ceylon. (Communicated by W. T. Thiselton Dyer, F.R.S., F.L.S.)

[Read June 1, 1882.]

In a recent paper * I have systematically brought together the main facts concerning the morphology of *Hemileia vastatrix* discovered up to May 1881, and have shown that in essential points of structure and development this remarkable fungus presents features sufficiently numerous and important to suggest its alliance with known *Uredineæ.* During the progress of an investigation occupying nearly two years, I have accumulated numerous observations of no less weight, proving that, in its physiological and pathological peculiarities, *Hemileia* also reminds us of the behaviour of the Uredine fungi †. Since many of the experiments upon which these conclusions are based are of an exhaustive nature, while some few are more or less novel in character, I propose to bring them forward in detail as further evidence in support of the now widely accepted view on the relations of parasitic fungi and their hosts generally, and of the Uredineæ in particular.

Those who have followed the more recent history of the so-called "Coffee-leaf disease" of Ceylon will recognize that several of the details entered into below are not new. I have restated, in a more systematic form, one or two facts already published in periodical reports ‡, apart from matters of comparatively local interest, in order to aid in the comprehension of their important bearing upon the subject under discussion.

For the sake of completeness, moreover, as well as because such a *résumé* possesses considerable advantages for and by itself, I shall enter upon several points in the general theory of parasitism, so ably and firmly established of late years by De Bary § and fellow workers, and upon which my researches

* Quart. Journ. Microsc. Sci., January 1882.

† The details are published in three Reports to the Ceylon Government, 1880–81.

‡ *Vide* Esp., "Third Report to Ceylon Government," Sessional Paper xvii. 1881.

§ *Cf.* De Bary, 'Die Brandpilze,' 1853, part iii., and Frank, 'Krankheiten d. Pflanzen,' p. 447 &c., and lit. quoted.

help to throw light. The economic aspect of "leaf-disease," as affecting the coffee-plant and the production of a large staple, need not be here commented upon; for the proper appreciation of the facts and their bearings, however, it may be advisable to state shortly some peculiarities of climate, &c. under which coffee is cultivated in a tropical island such as Ceylon.

If we confine our attention to the coffee growing, for example, on the hilly slopes of the great south-western coffee-districts, the following *general* statements are true. The trees are arranged in rows on the hill-sides, the stems some 5 to 6 feet apart and under 5 feet high: the branches and main stem of each tree are so pruned and trained that they form a thick shrubby head of leafy shoots, touching, or nearly so, the corresponding branches and twigs of each nearest tree. Apart from changes produced by special causes, the normal course of phenomena on a mass of trees such as has been sketched during the year would probably be, shortly put, somewhat as follows.

During the dry hot season from January to March few young leaves are formed, but the foliage already on he branches is actively at work, under a blazing sun, supplying materials for the flowers, which succeed one another in clusters during this time, and for the future demands of the trees; occasional showers or rainy days supply necessary moisture to the roots, but little or no dew forms during the dry nights towards the end of the period. The wind (which during the early part of the year may be plentiful, but is commonly slight later) is dry, and comes chiefly steadily from the N.E.

Some time near the beginning of what we may term the second three months (April to June), the rainy weather sets in, and the hitherto dry atmosphere becomes more or less saturated with moisture. An obvious consequence of these changes is the renewal of growth on the part of the trees, and new leaves and shoots are rapidly formed in the early portion of this period, while the fertilized flowers produce young fruit in the successive clusters. During the showery weather, or at periods more or less alternating, the wind is frequently gusty and heavy. On the whole, however, while the dry and often drooping coffee of February and March has to depend on occasional rains to bring out its numerous flower-buds, the April and May rains fill out the young fruits and force new leaves from the buds, and a general state of turgescence is enjoyed by the tissues of the plant. The warm cloudy days

and nights prevent dangerous evaporation or radiation, though boisterous winds may injure the tender shoots mechanically.

About the end of the last or beginning of the next of our arbitrary periods, *i. e.* July to September, the S.W. monsoon sets in, accompanied by continuous and heavy rains and winds; July and August are frequently characterized by fine hot weather, with alternate showery and cloudy intervals, the S.W. wind becoming more gentle and continuous; while September commonly ushers in another warm damp period, when moulds and mildew luxuriate in the steamy atmosphere.

In the fine weather, which usually characterizes great part of the next three months, the "picking of crop" is carried on; the trees become weary, so to speak, as their last fruit ripens, and little more growth is noticeable after November; the leaves formed in September have attained their full size and normal dark colour and leathery texture, and a state of comparative rest is characteristic of December and January.

Having premised these facts, the importance of which will be more evident as we proceed, I may sketch in a similarly general manner the phases of the malady known as "Coffee-leaf disease" as they commonly occur in the districts named. From the middle of January to the end of March the orange-red "rust" spots, so characteristic of this disease, are either altogether absent or rare; during April and May the spots occur here and there, chiefly on the older leaves, and very rarely on the young ones. In June and July the great and disastrous annual "attack of disease" usually becomes manifested by the myriads of yellow spots breaking forth from the leaves in all stages, each producing its masses of orange-red "rust;" and from this time forwards, until the dry weather is again fairly set in, the disease is constantly present, fluctuating in intensity according to circumstances. It generally happens, indeed, that another severe "attack of the disease" occurs about December or January; and in rare cases, as in wet ravines, the disease-spots do not completely disappear all the year round.

It became an important part of my duty to ascertain clearly what conditions influenced the rise and fall, so to speak, in the virulence of the disease; it was therefore necessary to obtain an accurate knowlegde of all the circumstances affecting the life of the fungus causing the latter.

Having ascertained that the spore ("uredospore") of *Hemi-*

leia, germinating on the damp under surface of the coffee-leaf, emits a short, delicate tube which sends a prolongation through a stoma, and that the further development of this results in the production of the intercellular mycelium, a point of departure for further investigation was established.

The presumption was fair, considering the analogies discovered between *Hemileia* and other parasitic fungi, that this ingrowth of the germinal tube is the true "infective" act; and I proceeded to ascertain if leaves on which spores were thus sown developed disease-spots, while others did not. Experiments made during the latter part of 1880 and the early months of 1881 established conclusively that this was the case. Having selected a number of seedlings which had been carefully grown under cover, from washed seeds, in baked earth, and which had presented no signs of disease, spores were sown on certain leaves of sixteen of the plants.

The sowing in each case was performed as follows:—A large drop of water was caused to adhere to the under surface of the leaf, and in this suspended drop a number of the orange-coloured spores of *Hemileia* were carefully placed with a needle. A small glass chamber (formed by a glass ring, covered by an ordinary "cover," and a piece of bibulous paper with a hole punched through the centre) was then clipped over the drop, and kept moist by means of blotting-paper on which a siphon was allowed to play slowly. All the plants were kept in a well-lighted, thoroughly ventilated room, of which the average temperature was 78° Fahr. At various intervals, spores were carefully removed from one of the damp chambers and examined; the details of germination have been fully described elsewhere*.

All the plants were watched day after day, and the leaves examined to see if any "disease-spots" appeared. At length "disease-spots," or yellow patches, were seen to have arisen one after another, until fifteen of the infected plants had developed these normal symptoms of the malady. After carefully examining the whole experiment, and allowing a considerable time to elapse after the appearance of the first spot, I was driven to the following conclusion:—

The "disease-spot" was only developed on those leaves and plants whereon sowings of the fungus-spores were made; moreover, the yellow spot made its appearance only in the immediate

* Quart. Journ. Micros. Sci., January 1882.

area where the spores were sown, and nowhere else on the plant, even when the latter was subsequently kept for several weeks. During the same period I further made numerous isolated experiments, none of which contradicted the above conclusions. I need not dwell upon the agreement between these results and those obtained from the anatomy of the fungus, nor is it necessary to point out the analogy between the phenomena of *Hemileia*-infections and those obtained for Uredinous fungi*. The possible reply, that I had induced special conditions within the glass chambers, not realized on the various check-plants, led me to alter the details of the experiments by using damp bell-glasses; and I found that, provided every care was taken to ensure the absence of spores, even very damp plants did not become infected.

Here, then, in the results of experiments looked at in the light of the anatomical facts, was proof that the act of infection consisted in the emission of something from the spore, which made its way into the leaf and caused the disease. The microscopical examination of spores and leaves proved that this "something" is a germinal tube—a direct outgrowth from the spore.

I next proceeded to inquire if any constancy is evinced in the periods necessary for (1) complete germination, (2) complete infection and the formation of the internal mycelium, (3) the formation of the yellow spot and "rust," and (4) in the duration of the activity of the spot.

With respect to the germination of the spore, the following facts have been established by numerous experiments and observations. Germination can only occur if the spore be in contact with water for a sufficiently long period. If the spore has been completely desiccated for some time, as is the case with spores which have been formed at the commencement of the dry season, several days may be required for the successful formation of the germinal tubes; but with quite fresh ripe spores, produced in the moist atmosphere of the south-west monsoon, the changes are effected much more rapidly. In from 12 to 24 hours after the removal of the ripe spore from its mycelium, the tubes sometimes commence to form, and, as a rule, the whole cycle of germination (*i. e.* the formation of a complete germinal tube, the end of which has commenced to block up the orifice of a stoma) has been gone through.

* *Vide* De Bary, Monatsber. d. Berl. Akad. 1865, and lit. quoted.

From the facts that spores may remain dormant on the leaves during dry weather, and that they may retain their capacity for germination for several weeks if gathered dry and kept in cool, dry, sealed glass-tubes, the proof that moisture is necessary for their germination becomes strengthened; and this is, of course, in accordance with what we know of other similar germinating bodies*.

That oxygen is also necessary may be demonstrated: germination is delayed or prevented if the spores be immersed in small air-tight chambers. Too low a temperature, as on flat open spaces, chilled by radiation to near the freezing-point, as well as artificially high temperature, kill the spores. Their rapid and vigorous germination at or near the temperature of 75° Fahr. is sufficiently established by numerous successful experiments.

I demonstrated on several occasions the fact that the uredospore germinates well in the open on young vigorous coffee-leaves in the warm, damp atmosphere of the S.W. monsoon, and also showed that spores germinate under such conditions on the soil, in the meshes of exposed canvas-cloth, and on glass, &c.; whence it may safely be inferred that, given the conditions for germination, any spore may throw out germinal tubes. If this occurs on the under surface of the coffee-leaf, the chances are infinitely in favour of the leaf becoming "infected" through its stomata.

Complete infection may be taken to mean the successful establishment of the mycelium (derived from the germinal tube passing through the stoma) in the intercellular passage of the leaf. By cutting sections of the coffee-leaf at various periods after the spores were sown as above, it was shown that on or about the third day after the formation of the germinal tubes, the diverticula sent through the stomata were becoming established within the leaf as branching mycelial structures; while further comparisons demonstrated that during the second week after the sowing a well-branched and vigorous mycelium occupies that part of the leaf covered by the area on which the spores were sown. So constant are these phenomena that one could depend upon having preparations in a given stage for each three or four days after infection.

From further observations it became clear that when the inter-

* NOTE *added August 8th.*—Spores of *Hemileia*, received by post from the Royal Garden, Kew, in July 1882, were successfully germinated in Strassburg on July 18–20th; these specimens came from the island of Réunion.

cellular mycelium has attained a certain development, its branches have blocked up many of the lacunæ, and having sent *haustoria* into the cells bounding them, the tissues of the affected area become paler in hue, the contents of the cells are disorganized, and a yellowish discoloration becomes visible on the exterior of the leaf. This discoloration (the incipient "disease-spot") is readily detected after a little experience, though during the first or second day it may be but slightly perceptible.

This stage, the first evidence of the presence of disease to the unaided eye, may be looked upon as a distinct one in the cycle of development of the fungus; and I will give one or two examples to show how constant and well-defined is the period at which a vigorous mycelium may be known to be present, as evinced by the yellowish incipient "disease-spot" seen from without.

α. Spores were sown in the manner described on the living coffee-leaf on July 24th; the pale spot appeared on August 7th, *i. e.* 14 days after.

β. Spores were sown on January 30th; the spot appeared on February 13th, also 14 days after.

γ. Spores were sown as above on October 20th; spot first visible November 3rd, also 14 days after.

Hence we see that a certain constancy appears observable in the rate at which the mycelium proceeds in its work of destruction. These examples, chosen simply to illustrate this fact, might be multiplied. However, it is not true that the "disease-spot" always appears on the 14th day; as will be shown, it may happen that one or two days more or less are required, according to circumstances to be examined; an average of nearly 14 days is very common, however, as shown by the following Table (I.), which summarizes shortly a number of experiments, selected from a large series, made to determine (1) the time occupied in the germination of a spore, (2) how soon afterwards the "disease-spot" appears on the leaf, and (3) how long the mycelium may continue to produce spores. In each case a vigorous young plant was selected which had been grown for some months in a sheltered situation, and was clean and healthy. On a recently-formed leaf a sowing of spores was made, kept moist for 24 to 48 hours, and then (the damp cell having been removed) placed in a carefully-cleaned Wardian case, well lighted, sheltered, and kept at an average temperature of about 78° Fahr. In all cases the spores were found to germinate in 24 hours and the

TABLE I.

Variety of Coffee.	Date on which spores were sown.	Date on which the "disease-spot" appeared.	Date on which spores were first seen.	Approximate date of greatest vigour.	Approximate date on which spot turned black in centre.	Approximate date on which spores ceased to form.	Time occupied in forming "disease-spot."	Time during which spores were continuously produced.
A. Jamaica	Jan. 27	Feb. 4	Feb. 6	Feb. 12	......	......	8 days	......
B. Do.	" 30	" 13	" 15	Mar. 1	April 25	May 1	14 days	10 weeks
C. Nakunaad	" 11	Jan. 25	Jan. 28	Feb. 6	Mar. 14	April 1	14 days	8 weeks
D. Do.	" 23	Feb. 4	Feb. 6	" 13	" 10	Mar. 31	12 days	7 weeks
E. Do.	" 22	" 3	" 6	" 14	" 12	April 1	12 days	7 weeks
F. Java	" 18	" 6	" 9	" 20	April 2	May 1	19 days	11 weeks
G. Do.	" 22	" 4	" 6	Mar. 1	Mar. 30	April 20	13 days	10 weeks
H. Indian..............	" 11	Jan. 26	Jan. 30	......	......	......	15 days	......
I. Ceylon..............	July 24	Aug. 7	Aug. 10	Aug. 20	......	......	14 days	......
K. Java	Aug. 1	" 17	" 20	......	......	......	16 days	......
L. Ceylon..............	Jan. 21	Feb. 3	Feb. 5	......	......	......	13 days	......
M. Do.	" 20	" 3	" 6	......	Mar. 20	......	14 days	......

On examining the above it will be noticed that the average of the 8th column (164/12) gives nearly 14 days (13·7) as the period between the date of sowing and that of the first appearance of the "disease-spot."

tubes had commenced to block up the stomata within 48 hours. For all examples, also, the following holds good: the "disease-spots" appeared on the leaf on which the sowing was made, and within the area of sowing, *and nowhere else on the plant.* Moreover, no more "disease" appeared on the same plant, even after keeping it for several (six to eight) months, unless a fresh sowing was made and kept moist for 24 to 48 hours as before.

These facts prove (1) that the "disease-spots" and "rust" result from the tubes and mycelium traced by the microscope from the spore; (2) that the fungus corresponds in area with the disease-spot; (3) that even if spores be present on the leaf, no "disease" results unless the conditions (moisture, &c.) for germination be also present. Finally, taken in conjunction with the results of microscopic analysis, they prove that the disease-spot is due to the action of an organism derived from without, which passes through definite changes and has a limited term of life.

It is therefore true that a certain approach to constancy is exhibited by the successive phases above described; and it is abundantly proved that the yellow "disease-spot" is the outward sign of internal injuries caused by the mycelium, and coextensive with it.

As soon as the yellow "disease-spot" has become obvious, the reproduction of the fungus takes place, as described elsewhere*; and the first appearance of orange-coloured "rust" or spores occurs on the outside. The outcome of all the observations shows that this takes place, on the average, about the third day after the first external signs of the yellow spot are evident.

Now it is plain that, as the above facts became established, one could predict, more or less accurately, when and where a disease-spot would appear on a given leaf on which spores had been sown and kept moist.

To illustrate this important point more fully, a few more experiments, as carried out, may be quoted.

Spores were sown, as described above, on a leaf of *Coffea arabica* on Oct. 15. From the known data, the disease-spot due to the action of the produced mycelium should be visible on or about Oct. 29–30, assuming rapid germination: the spot actually became visible on Oct. 29, in the area of the sowing, and nowhere else on the plant. Several other experiments gave similar results.

* Quart. Journ. Micros. Sci., January 1882.

On Dec. 12 I treated six seedlings in the same manner, sowing spores on the young leaves of five and on the cotyledon of the sixth specimen. All the seedlings were grown in the same pot and soil, and may be considered equal in all essential respects. A very faint spot appeared on each of the leaves of four specimens on Dec. 21st; a similarly indistinct spot was developed next day on the leaf of the fifth; but the spot on the cotyledon did not become visible till the 23rd.

Here, therefore, appeared a less successful attempt to predict the rate of development of the "disease-spot;" whereas I had expected at least 14 days to be occupied in the whole process, there were, in fact, only 9–10 and 11 days respectively so occupied. One more example:—

On Oct. 25 a sowing was made on a large, dark, tough leaf of *Coffea arabica* treated as usual. According to calculation, I searched for the "disease-spot" on Nov. 8 and 9; but no spot appeared, and no trace could be discovered till the morning of Nov. 11, when the yellow spot appeared as usual. Here about 16 days had been occupied in the formation of the given mycelium and spot.

In Table II. are summarized the results of further experiments of the same nature; these should be compared with those already published in the Third Report to the Ceylon Government (Sessional paper xvii. 1881).

Although in the above-cited examples, which have been purposely selected to illustrate all the chief points, it is evident that an absolutely accurate prediction did not always occur, some stress should be laid on the fact that the time allowed for the production of the "disease-spot" (viz. 14 days) proved correct in a majority of experiments.

It is now time to inquire if any explanation of the differences is forthcoming. During the progress of the investigation it became clear, as already stated, that spores which had been matured some time and become quite dry took longer to germinate than fresh spores which had just ripened: experiment also showed that spores which were produced during the moist weather could be made to germinate in a few hours, and might produce a normal and complete germinal tube within 12 hours from the moment of sowing. I had indeed found the uredospores germinating while still on the damp parent rust-patch; and the teleutospores commonly do so.

TABLE II. *Infection Experiments.*

Description of Coffee employed.	Date on which spores were sown.	Date on which "disease-spot" appeared.	Time occupied in producing the spot.	Date on which new spores appeared.	Remarks.
Nakunaad	Nov. 3	Nov. 20	17 days	Nov. 25	Very hard, dark, adult leaf.
Ceylon (*C. arabica*) ...	" 11	" 25	14 "	Dec. 4	Medium, ordinary green leaf.
Ditto	" 11	" 25	14 "	" 1	Ditto.
Ditto	" 11	" 25	14 "	" 8	Ditto.
Ditto	" 16	" 26	10 "	" 1	Ordinary young leaf.
Ditto	" 16	" 28	12 "	" 2	Ditto.
Ditto	" 16	" 28	12 "	" 9	Ditto.
Ditto	" 16	....	Failed	....	Ditto.
Ditto	" 16	....	Ditto	....	Ditto.
C. liberica	Dec. 12	Dec. 25	13 days	Jan. 1	Very young leaf.
Ditto	Nov. 28	" 16	18 "	Dec. 20-23	Large ordinary adult leaf.
Ditto	" 28	....	Failed	....	

Apart from accidents during the formation of the germinal tube*, therefore, it is clear that in a given experiment the act of infection by any one tube may be delayed or hastened according to the previous state of the spore as regards moisture &c. The outcome of my observations in this connexion is, that while the act of infection or entry of the germinal tube through the stoma may commence in 12 hours after the sowing of the uredospore, it may require 3 days or more. Nevertheless 40 to 48 hours is a very common period for the completion of this process.

Having taken this into account, however, and made experiments under such circumstances that the germinal tubes are found to be completely formed and entering the stomata during the second day, I find that several other factors complicate the question as to the period occupied in forming the spots. Not only does the vigour of the mycelium depend upon the amount of food and moisture present in the leaf, but also on the ease with which the proper materials can be obtained and assimilated. It is therefore clear that the age and condition of the coffee-leaf may influence the rate of development of the parasitic mycelium within it. (N.B. This has nothing to do with the *infection* itself; the difference is important.) We have seen that the period at which the yellow "disease-spot" makes its appearance depends upon the progress made by the mycelium in its work of destruction of the tissues: this may be affected by the thickness of the walls of the cells which are to be invaded, and also by their number in a given area of the leaf. The connexion between all these facts and the general healthiness and activity of the tree are obvious, whence must be inferred that any thing affecting the one may indirectly affect the other.

I will now describe a further series of experiments showing the kind of evidence which exists in fact for the above views. In October 1881 I commenced two series of experiments as follows:—

A. A number of plants of *Coffea arabica* were selected, which had been obtained from Samarang in a Wardian case, and had been two months in a cool, carefully ventilated room. These plants were one year old, still retained their early leaves, were healthy, dark green, producing new shoots and leaves. They had been removed without disturbing the rootlets, in each case a large cube of the original soil having been retained. There was

* Such as non-contact with a stoma, the attacks of insects, fungi, &c.

no reason to suppose these plants other than fair subjects for experiment.

A sowing of spores was made on the underside of a chosen leaf on nine different days from October 5 to 25, in the manner already described, with fresh, ripe, moist spores; and a slowly-dropping siphon played on the damp chamber for four days. On the fifth day the damp chamber was removed in each case, and, with a perfectly clean sponge filled with pure water, the adhering spores &c. were then washed off—the detection of the young "disease-spot" at its earliest appearance being thus rendered easier. The leaves were closely examined daily, and the following Table (III.) gives the summary of observations.

B. Nine young seedlings of *C. arabica* were selected which had been raised in pots in a closed Wardian case, and in soil dug from a depth with great care. Each seedling possessed its cotyledons, and one pair of thin, apple-green, succulent, and healthy leaves of a fortnight's growth; the second pair of leaves were just appearing. The sowings &c. were made exactly as before; and all circumstances were the same, except that the Wardian case in which these experiments were conducted stood in another room. I have no reason, however, to believe that the very small differences in the amount of light, air, &c. which may have existed could materially influence the results. The temperature of both rooms was nearly the same, viz. 75°–78° Fahr. on the average. The results are appended in Table IV.

It appears impossible to avoid the conclusion that, generally speaking, the thinner and more tender the leaf, the more rapidly does the "disease-spot" appear. If it be objected that the older plants, having travelled from Samarang some months before, were not fairly compared with the Ceylon seedlings, it may be justly remarked that the young and tender leaves on these plants also developed the spots more rapidly.

If, in the above instances, we take the average number of days occupied in producing the spots on the old leaves and compare with the time occupied in the case of the young ones, however, the difference is very striking: the numbers are $\frac{90}{6}=15$ days, against $\frac{129}{12}=10\frac{2}{3}$ days, for the old and young leaves respectively.

I do not imagine that the differences in the rate of development of the spots in the above cases were due simply to differences in the rate of infection. It has already been stated that freshly ripened spores produced in the moist season germinate rapidly; and it will be noted that slowly-dropping siphons were

TABLE III.—EXPERIMENTAL SERIES A.

Description of Leaf employed in the experiment.	Date on which spores were sown.	Date on which "disease-spot" first appeared.	Date on which new spores first appeared.	Time occupied in producing the "spot."	Discoloration extended through the whole thickness of leaf.	"Disease-spot" in full vigour (approximate).	"Spot" old and becoming exhausted (approximate only).	Remarks.
1. Leaf dark, thick, tough, and more than 5 months old.	Oct. 5	Oct. 21	Oct. 23	16 days	Oct. 30	Nov. 7	Dec. 5	Very large and productive spots, the spores hanging in dense masses. On Dec. 13 concluded observation. $\frac{4}{5}$ of leaf healthy and green on that date, and petiole sound.
2. Similar in all respects to the last.	Oct. 7	Oct. 23	Oct. 25	16 days	Oct. 30	Nov. 7	Dec. 6	On Dec. 17 the spot covered about $\frac{1}{6}$ whole area of leaf, and had turned black; rest of leaf sound. A few spores still forming.
3. Thinner and more succulent leaf, about 6–8 weeks old.	Oct. 10	Oct. 23	Oct. 26	13 days	Nov. 2	Nov. 10	Before December.	On Dec. 5 the leaf had become brown and shrivelled, and saprophytic fungi had attacked the spot. Leaf fell on Dec. 7.
4. Very young and succulent, a fortnight old.	Oct. 13	Oct. 24	Oct. 27	11 days	Nov. 22	Dec. 5	....	On Dec. 17 spores were still produced in large quantities.
5. Dark, thick, about 5 or 6 months old.	Oct. 15	Oct. 29	Oct. 31	14 days	....	Nov. 15	....	On Dec. 5 dense masses of spores were still being formed; $\frac{1}{4}$ of whole leaf destroyed. On Dec. 17 two new spots had arisen (from germination of new spores?).
6. Young, succulent leaf.	Oct. 17	Oct. 31	Nov. 7	14 days	Dec. 7	Dec. 16	....	Leaf fell on Dec. 19 or 20.
7. Dark, thick, and vigorous.	Oct. 20	Nov. 3	Nov. 7	14 days	Dec. 5			
8. Young leaf	Oct. 23	Nov. 4	Nov. 9	12 days	Dec. 5	Dec. 17		
9. Old, dark, leathery leaf.	Oct. 25	Nov. 11	Nov. 16	17 days	Dec. 5	Dec. 13	....	On Dec. 13 this leaf was taken for histological purposes. The black spot was surrounded by dense masses of spores. All other parts of leaf and petiole green and healthy.

TABLE IV.—EXPERIMENTAL SERIES B.

Description of Leaf employed in the experiment.	Date on which spores were sown.	Date on which "disease-spot" first appeared.	Date on which new spores first appeared.	Time occupied in producing the "spot."	Discoloration extended through the whole thickness of leaf.	"Disease-spot" in full vigour (approximate).	"Spot" old and becoming exhausted (approximate only).	Remarks.
1. Very young and succulent.	Oct. 5	Oct. 18	Oct. 21	13 days	Nov. 1	Nov. 18	Dec. 1	On Dec. 17 spores were being feebly produced at the margins of the black patch.
2. Ditto	Oct. 7	....	....	....	....	....	....	No disease-spot had appeared up to Nov. 20; therefore discontinued experiment.
3. Ditto	Oct. 10	Oct. 21	Oct. 23	11 days	Nov. 6	Nov. 18	Dec. —	On Dec. 5 the whole leaf was rotten and dropped on touching.
4. Ditto	Oct. 13	Oct. 24	Oct. 28	11 days	Nov. 20	Nov. 30	Dec. 5	Spores only produced in small quantity at any time. The soil was poor, and many small worms were found afterwards at the roots. The leaf rotted and fell off on Dec. 10, and whole plant was rotten on Dec. 17.
5. Ditto	Oct. 15	Oct. 24	Oct. 29	9 days	....	Nov. 21	Dec. 8	The whole leaf was rotten and fell on touching. Soil too damp?
6. Ditto	Oct. 17	Oct 30	Nov. 2	13 days	....	....	....	Leaf bitten off by cockroaches on the evening of Nov. 5.
7. Ditto	Oct. 20	Oct. 31	Nov. 4	11 days	Nov. 21	Dec. 5	Dec. 17	But still many spores produced.
8. Ditto	Oct. 23	Nov. 2	Nov. 5	10 days	Nov. 18	Dec. —	Dec. —	On Dec. 17 the leaf was rotten over half its area, and dropped on shaking the pot.
9. Ditto	Oct. 25	Nov. 4	Nov. 8	10 days	Dec. 6	Dec. 16	....	The spores produced were not numerous, but slowly formed during January.

used in all cases, a method which almost ensures immediate and successful germination, as had been largely experienced with other sowings.

Nor do I think that slight differences in the soil, affecting the supply of food and water to the plant, unduly influenced the two sets of experiments. Nevertheless, while insisting on the fact that *the* great difference between the leaves in which the mycelium produced the spots in 10 days or so and those in which it required 15 days on the average, was that in the former the cell-walls were thin and soft and less numerous, yet it must be allowed so far that slight differences in the circumstances (light, air, and possibly temperature and moisture) existed, while unknown differences may have been presented in the quality and quantity of food and water absorbed by the roots, in the vigour of the plants generally, and (though experiments do not support this idea) in the rapidity of actual infection—all of which might more or less, though very slightly in the individual cases, affect the physiological activity of the mycelium, and therefore the accuracy of the conclusions.

Passing to the consideration of the question, How long may a "disease-spot" continue to produce spores?, I may refer for details to the tables and to results already published. These were obtained by (1) marking certain leaves in the open, and noting when the development of spores ceased; and (2) making experimental sowings as above detailed, and watching the progress of the spots. By these means it was shown that the spores may be continuously produced for from 7 to 11 weeks; and there can be no doubt that the extreme limits are not here stated.

One interesting and important observation may be recorded. On a "disease-spot," produced on the leaf of a protected plant in a Wardian case, the successively developed spores hung in clusters in the perfectly still, moist air. From certain known data as to the number and length of these clusters, and the average size of the single spore, I was able to estimate the quantity of spores present; these were probably more than 150,000. Now, since 127 disease-spots have been counted on one pair of leaves, some idea of the enormous quantity of spores produced may be readily obtained.

The slightest shake causes these spores to fall; and it may be proved directly that others are formed very rapidly by the same spore-heads. By gently brushing off the spores with a camel-hair pencil no injury is done, and in a few hours others are found

to have been formed in the moist atmosphere. The development of new spores may also be shown to proceed on leaves which have fallen to the ground, and in which a supply of food and moisture is still afforded to the spore-producing mycelium.

The time during which the production of disease-patches and spores on a leaf may continue must necessarily depend upon a number of circumstances. Where one disease-spot only occurs on a coffee-plant, it may go on forming spores for many weeks. In given cases I have observed this process for from 10 to 16 weeks and longer; but if several spots form on the same leaf, their period of activity is shortened by the premature fall of the leaf. It may well be, also (though I have no *direct* proof of this) that in the latter case each spot produces fewer spores in a given time; since, where there is a struggle for food-supplies among several independent mycelia, it is unlikely that all are as abundantly supplied as one would be.

The following Table (V.) summarizes the results of observations made to determine (1) how long a time is occupied by the coffee-plant in forming a complete pair of leaves, (2) at what period they become attacked by the fungus, and (3) how long they survive the ravages of the pest. In all the specimens selected there were several of the disease-spots on each leaf; but, of course, no absolute standard of the damage done is given. The following example will illustrate the mode of reading the columns. Taking the specimen F, the minute terminal bud evident so early as September 6th, 1880, remained quiescent during forty days (till October 16th), and then commenced to swell and unfold its pair of leaves. In about a month's time (November 15th) the leaves were completely formed and in full activity, and apparently clean and healthy. November 18th was the last date on which no trace of disease was visible to the naked eye; but it is evident, from what is known of the periods in the life-history of *Hemileia*, that the germinal tubes had already entered the stomata, and formed mycelia; for on November 23rd the yellow spots were apparent, and had developed spores before December 5th. The formation of spores continued, and the leaf was badly diseased with "rust-patches" before December 22nd, when the spots were already old and turned brown. On January 1st, 1881, the leaf had fallen; and an examination of the last two columns shows that, out of 2½ months' term of life, the leaf was obviously pestered with the fungus half the time. Moreover, we must recollect that nearly a

TABLE V.

	Date on which the bud was first noticed.	Date on which unfolding of leaves had begun.	Date on which leaves may be considered adult.	Last date on which leaves appeared quite clean.	Date on which the "disease-spots" were first noticed.	Date on which the spores were first noticed.	Date on which the leaf was badly "diseased."	Date on which the spots were brown.	Date on which the leaf fell.	Total life of unfolded leaf (approximate).	Time during which the "disease" was visible (approximate).
										Weeks	Weeks
A.	Aug. 27	Aug. 30	Sept. 30	Oct. 16	Oct. 20	Oct. 29	Nov. 18	Dec. 1	Dec. 22	11	8
B.	„ 29	„ 30	„ 30	„ 29	Nov. 1	Nov. 8	Dec. 5	„ 5	„ 20	11	7
C.	Sept. 14	Sept. 17	„ 30	Sept. 30	......	„ 7	Nov. 23	......	„ 5	9	5
D.	„ 30	Oct. 20	Nov. 15	Nov. 15	Nov. 16	„ 18	„ 30	Dec. 22	„ 30	6	6
E.	Aug. 20	Aug. 26	Oct. 16	Oct. 29	„ 1	„ 8	Dec. 5	„ 22	Jan. 1	10	8
F.	Sept. 6	Oct. 16	Nov. 15	Nov. 18	„ 23	Dec. 5	„ 22	„ 22	„ 1	6	5
G.*	Oct. 29	Feb. 1	Feb. 27	Mar. 14	Mar. 29	0	0	0	June 29	16	0
H.	„ 30	„ 1	„ 27	April 25	May 8	May 25	June 29	July 15	Aug. 3	21	10
I.*	Jan. 30	„ 10	Mar. 14	May 8	0	0	0	0	July 6	16	0
K.*	„ 30	„ 5	„ 10	June 26	July 6	0	0	0	Aug. 10	21	0

N.B.—In the examples marked (*) the leaf never became badly diseased, but at most one or two "spots" appeared and produced no spores at all; and it is doubtful if the mycelium of the fungus was ever present to any large extent. In all the other cases about 10 to 15 "disease-spots" appeared on each leaf, and produced spores as described.

month (October 16th to November 15th) was occupied in bringing this leaf into full activity, and probably a fortnight must be added to the last column, during which time the mycelium was forming. How little of the total life and powers of such a leaf benefited the tree will be evident on comparing these results.

The method adopted in arriving at these conclusions was to mark a given vigorous twig, and note the progress of the bud, fungus, &c., at intervals of a few days. No other conclusions than those for which the tables are designed are intended to be drawn: *e. g.*, in the example given, the date December 5th (in the 6th column) does not mean that *the first spore formed on that day*, but that, taking notes of the progress of events on December 5th, I found *spores were already formed by the spots in some quantity*, whereas they were not present when notes were taken some days earlier.

To take another example (K), we find a very different series of events when no mycelium or only an odd spot appears: here the bud of January 30th began to unfold in February, and reached its full development as a pair of leaves about March 10th. Up to June 26th no signs of disease had appeared; and we notice that the traces of spots noted on July 6th never came to anything, as signified by "0" in the column. The leaf fell on August 10th, after a total life of 21 weeks or so. In such a case we may safely assume that its work was chiefly devoted to the benefit of the tree.

I shall have occasion shortly to point out the importance of the fact that one or two "disease-spots" do not suffice to destroy the leaves: a luxuriant tree may support a certain amount of fungus, as well as a large quantity of fruit. Meanwhile attention may be directed to some experiments showing that the greater the quantity of mycelium (and therefore of "disease-spots") the sooner the leaf falls (Table VI.).

To take an example (F): on December 20th the leaf was adult and in full working order. It retained its green, bright colour until April 2nd, when a few faint yellowish cloudy patches were observable, the signs of approaching dissolution.

On April 25th the leaf had become yellow, like an autumnal leaf in Europe, and fell soon after, about May 3rd, having done its work for the tree, but having escaped the ravages of the mycelium of *Hemileia*.

TABLE VI.

Date on which leaf may be considered fully formed.	Date about which leaf began to turn yellow.	Date on which leaf was quite yellow.	Date on or about which the leaf fell.	*Hemileia*-spots absent or present.	Length of time the leaf remained (approximate).
A. June 26	September 30	October 10	October 16	None.	16 weeks.
B. November 22	February 15	February 24	March 1	One minute spot on February 22.	16 ,,
C. December 20	April 2	April 25	May 3	None.	20 ,,
D. July 18	November 8	November 15	November 18	None.	17 ,,
E. July 16	,, 15	,, 20	,, 21	Four small dull spots in November.	18 ,,
F. January 2............	April 25	May 1	May 8	None.	18 ,,

N.B.—These examples should be compared with examples G, I, and K in Table V. It is to be noted that none of the small spots taken into account here were either very vigorous or present for a long time before the leaf fell. It is also worth remark that 20–21 weeks is the longest period I have yet found a coffee-leaf to persist on the trees in the open.

An instructive series of observations were made to obtain an answer to the question, How long will the leaf remain on the tree when not attacked by *Hemileia*, and when only one or two small and barren disease-spots appear?

It was shown that leaves on which no disease-spots appeared commonly remained on the tree for 18 to 20 weeks and longer; whereas leaves on which numerous spots were developed fell in 6 to 11 weeks, or even sooner, after the unfolding of the buds. It may be imagined how differently two trees must be affected, if the leaves of one escape the ravages of *Hemileia*, and are permitted to work for the good of the tree during 18 to 20 weeks; while those of the other have to work (so to speak) for the benefit of the fungus as well, and yet persist but 6 or 8 weeks in all. Every degree of difference in these relations occurs in masses of diseased coffee.

Having thus examined more or less in detail what occurs in laboratory experiments, and having drawn certain conclusions as to the behaviour of *Hemileia* when the chief circumstances are under control, we may pass to the description of its behaviour in a state of nature, in the open, and see how far this is explained by the known facts.

In proof that a "disease-spot" is formed exactly as before on coffee exposed naturally, I may cite the following experiment, which will also serve to illustrate other points of importance:—

On December 23rd, 1881, a Wardian case was received from Jamaica, in which were eight living coffee-plants in bamboos containing Jamaican soil; in this rich dark mould flourished a dense mass of healthy roots, and each plant possessed a fair supply of vigorous leaves.

Two of these plants were transferred to the open ground, being plunged into the soil without any disturbance of their roots or soil; these may be called A and B respectively.

Two (C and D) were placed undisturbed in a cool shaded room, from which draughts of wind were carefully excluded.

Two others (E and F) were placed untouched in another room, more exposed to light and air, and, like the rest, were watered regularly.

A seventh specimen (G) was placed, also untouched, in a closed but light and well-ventilated Wardian case.

The eighth plant (H) was placed in the same room as E and F, and under similar conditions. On the exposed plants A and B spores were scattered from a neighbouring "diseased" tree,

the leaves being already wetted by a drizzling rain; one leaf was then marked on each plant, and spores carefully placed on each in drops of water on the under surface.

On one leaf of plant C a sowing was made, under the siphon &c. as usual; D remained untouched.

E and F remained untouched, as also did G. One leaf of H was infected under a siphon as usual. All this took place on December 23rd.

On January 3rd, 1882, several leaves from both the exposed plants (A and B) had been torn off by wind &c. On several of the younger leaves were distinct, though small disease-spots; these were particularly noticed on the marked areas. During the following week the spots increased in number and vigour, and there could be no reasonable doubt that the plants had been infected as described earlier, and that 11 days (December 23 to January 3) had been occupied in the process.

On January 4th a "disease-spot" appeared on the leaf of the plant C, where spores had been sown 12 days previously; no trace existed on D, however, either then or later.

The plants E, F, and G remained without a trace of disease up to January 12th, and no reason existed for supposing that any mycelium or "disease" was imminent.

The plant H, at the spot where spores had been sown 13 days before, developed a "disease-spot" on January 6th, on which spores appeared on January 10th.

Now this experiment, the latest which I performed in Ceylon, appears in some respects the most instructive and conclusive which has yet been offered.

It seems clearly to prove, 1st, that the nature of the soil, coffee-plant, and past circumstances &c. have nothing to do with the possibility of infection; 2nd, that previous experiments had conclusively established the normal course of the "disease;" and 3rd, that, provided the plants are kept sheltered from the fungus-spores, there is no fear of their incurring the inroads of the pest.

For additional evidence on these points the reader is referred to my previous Reports.

With regard to the exposed plants A and B, it may be asked, How was the moisture necessary for germination supplied, since no siphon was used? The answer is given by my diary of the weather. The week before was cloudy and showery, and the spores employed were already prepared for rapid germination. Then:—

December 23rd. Drizzling rain; cloudy afternoon; rainy night.

December 24th. Cloudy, with sunny breaks. Cool. No rain.

December 25th. Sunny and hot, with cloudy intervals.

The germination must have occurred in these intervals.

At various times experiments had been made to determine how the spores, which were observed germinating naturally on the coffee, arrived at their proper positions on the leaf. Careful observations on diseased coffee, made during gentle showers and steady breezes, convinced me of the following facts. Bearing in mind what an enormous quantity of orange "rust," each grain of which is a spore capable of reproducing a "disease-spot" in less than three weeks, may be produced by one spot, and remembering also how easily these spores are detached, it seemed probable that the disease-spots produced later on a leaf might arise from spores shaken or washed from the earlier spots.

If a perfectly clean glass slip, 3 in. × 1 in., be clipped on to a branch of coffee in the position of a leaf, in moist weather, two facts appear:—(1) spores, not only of *Hemileia*, but also of Sphæriæ, Lichens, &c., may be observed on the slip in the course of several hours; (2) these and other small bodies tend to accumulate at the lower edges or tip of the glass, and even to travel to the lower surface and become suspended in the moisture pendent therefrom.

That the spores &c. are washed, shaken, and blown into such positions aided by the action of gravitation cannot be doubted; and this view explains why the earlier disease-spots on coffee-leaves, which have not been violently shaken, frequently appear at the edges and tips, subsequent spots appearing in the other regions of the leaf. These causes, combined with violent shakings during gusty and rainy weather, must contribute largely to distribute spores from a diseased spot to a healthy part of a leaf, from one leaf to another, and even from tree to tree. But other observations prove that the wind conveys the spores of *Hemileia* through longer distances than the above. By exposing slips of glass, smeared with a thin layer of glycerine, in various positions in the neighbourhood of diseased coffee, it was shown that spores of *Hemileia* became entrapped in the glycerine; in one remarkable experiment the glass slips were exposed for 12 hours in a vertical position (the side smeared with glycerine facing the coffee) during a very high wind. The glass slip was 5 feet from

the ground, and 18 feet in a direct line from the nearest coffee-trees; on these trees the spore-forming "disease-spots" were abundant and active, and spores were being plentifully shaken from them. At the end of the 12 hours I found no less than 117 spores of *Hemileia* embedded in the glycerine. Many other experiments confirmed the conclusion that the wind conveys the spores over considerable distances; innumerable spores, in all stages of freshness and decay, were observed in the meshes of some canvas exposed among the coffee for several months.

TABLE VII.

Month.	State of the Disease.	Wind.	Distance of glass slip from Coffee.	Distance of glass slip from ground.	Method of exposure of the slip.	Length of exposure.	No. of *H. vastatrix* spores found.
June 3	A few spots of "rust" here and there.	High.	12 feet	On the grass.	Flat.	8 hours	7
July 8...	Bad.	Very high.	25 "	4 feet	Vertical.	12 "	21
July 9...	"	"	20 "	4 "	"	2 "	8
" ...	"	"	12 "	5 "	"	2 "	13

How far the agency of man and insects &c. is responsible for distributing the spores has not been directly determined; but it is fair to assume that this also comes into play.

Hence it is certain that the spores of *Hemileia*, passive though they are, become plentifully distributed among the coffee on estates. If, as in the highest degree probable*, the fungus became conveyed to the cultivated coffee from the surrounding forests, it is easy to understand how its spread would be at first slow (since many spores are known to fail in obtaining a suitable starting-point); but we may also as easily comprehend that a large stock of spores having become formed in a favourable damp and warm season, the rapid spread over a wide area of coffee-trees would be but a matter of time. That this has occurred during the last fifteen years in Ceylon is only too evident.

The spores of *Hemileia*, then, can become spread over the

* For evidence of this *cf.* Third Report, &c.

coffee; the necessary conditions for their germination are known to recur naturally at frequent intervals; and experiments have conclusively shown that within three weeks from the successful sowing of any spore on a coffee-leaf the mycelium reproduces spores again, to go through the same cycle.

Moreover, evidence has been brought to show that any kind of coffee may become infected, though of two given leaves the younger and thinner one usually shows the "disease-spots" more rapidly. How far do these and similar facts explain what occurs on masses of coffee?

I have shown in detail elsewhere * that in the districts chosen for illustration, young coffee-leaves are formed most rapidly during the "growing weather" of April to August, and that, practically, the quickest development of new leaves occurs during May and June. On the contrary, very few leaves are produced during the hot dry season of February and March. Alternations of rapid and slow growth occur during the rest of the year, depending on the variations of climate experienced; but it commonly happens that a rapid renewal of growth occurs towards the end of the year, in October and November.

To determine as far as possible the rate of growth and other changes in leaf-buds and leaves at Péradeniya, certain trees were selected in August 1880, and watched during the following twelve months, notes being made at short intervals as to the conditions of the buds and leaves on twigs around which coloured ribbons had been loosely tied.

The shortest time in which a pair of leaves was developed in my experiments was about 4 weeks, when the bud first exposed on April 10th became an adult pair of leaves by May 8th; and the longest period occupied by the same process was (excluding a very abnormal example, where 17½ weeks were occupied in the process) 13 weeks, when a bud which first appeared free on October 29th did not begin to open until the following January, and its leaves were not fully formed before February 27th.

During the very dry weather experienced in Péradeniya from December to March, there is, on the whole, much less activity displayed in the formation of leaf-buds and leaves than during the period from April to August; and this is in accordance with the general experience of planters on the Kandy side of Nuwara Eliya. Of course there are differences in the rate of development of leaves, dependent on circumstances other than the

* Appendix to Third Report.

TABLE VIII. *Branch A.* (Tree not Pruned.)

Date on which bud became visible.	Date about which bud began to open.	Date when the leaves separated.	Date on which the leaves were full sized, &c.	Time occupied in opening, &c. (approximate).	Whole period of development (approximate).
August 2	August 26	September 6	October 16	7 weeks	$10\frac{1}{2}$ weeks
September 6	October 16	October 29	November 15	4 ,,	12 ,,
October 29	January 10	February 1	February 27	7 ,,	13 ,,
......	February 1	,, 20	March 29	8 ,,	......
March 7	March 29	April 5	April 25	4 ,,	7 ,,
April 25	May 20	May 25	June 15	$3\frac{1}{2}$,,	7 ,,
May 25	June 15	June 26	July 14	4 ,,	7 ,,
June 26	July 6	July 18	August 1	$3\frac{1}{2}$,	5 ,,

On this branch, therefore, eight pairs of leaves were completely formed during the 12 months (August 1, 1880, to August 1, 1881), the period of slowest growth being September to February; that of quickest growth, April to August. The pair of leaves which developed most rapidly was formed in June to July; that which developed most slowly, in January to February.

TABLE IX. *Branch B.* (Not Pruned.)

Date on which bud became visible.	Date about which bud began to open.	Date when leaves had separated.	Date on which leaves had attained full size, &c.	Time occupied in opening (approximate).	Whole period of development (approximate).
August 5	October 10	October 16	November 8	4 weeks	12 weeks
November 1	January 20	—	February 25	4½ "	17½ "
......	February 21	March 7	April 25	9 "	......
March 7	March —	" 30	" 30	......	7¼ "
" 30	April 14	April 20	May 2	2½ "	4½ "
April 20	" 25	May 1	" 30	4½ "	5 "
" 30	July 6	July 20	August 8	5 "	6 "

TABLE X. *Branch C.* (Pruned Tree.)

Date on which bud became visible.	Date about which bud began to open.	Date when leaves had separated.	Date on which leaves had attained full size.	Time occupied in opening (approximate).	Whole period of development (approximate).
January 22	January 30	February 10	February 27	4 weeks	5 weeks
" 31	February 10	" 24	March 14	4½ "	6 "
February 24	April 2	April 15	May 1	4 "	5 "
April 10	......	......	" 8	......	4 "
May 1	May 8	May 20	June 20	6 "	7 "
" 25	June 15	June 20	July 15	4 "	7 "

weather, since the time at which pruning, manuring, &c., are done affect these and other phenomena; moreover, since the buds are slower in development where winds or a general low temperature prevails than where the air is quiet and warm, it will be evident that elevation affects this as other processes of growth. The trees on which my observations were made, suffer much from leaf-disease, and bear little crop, circumstances which must also be taken into account.

Let us now suppose, for the sake of argument, that a quantity of spores of *Hemileia* are scattered about the above-named districts in January, after the dry season has fairly set in; many of these spores may be imagined on the rocks, ground, tree-stumps, &c. around, while others are on the leaves of the coffee. The air is so dry that, except on the banks of sheltered streams and in damp shady places, those spores cannot germinate; the wind is not high, and even in cases where sudden gusts raise spores from dead and "diseased" leaves on the ground, there are comparatively few leaves on the trees, and the chances of many spores attaching themselves to their dry surfaces are not great.

With the April rains and gusty winds there come in circumstances which distinctly alter the circumstances of these spores: a few of these spores on the leaves germinate, infect the leaves, and in three weeks reproduce their kind in the normal manner. By the time that the May leaves are becoming formed, a somewhat larger stock of *Hemileia*-spores exist on the trees than before; and these newly-formed spores are better placed for distribution—every shower of rain and puff of wind must scatter some of these spores.

During May and June the weather is not unfavourable for the germination of the above-named spores; by the time that this second generation has gone through its cycle, the older spots are still producing vigorous spores in the moist atmosphere, while the wind may successfully place others from the original sources of infection.

It must be remembered that the trees are by June becoming densely clothed with young, succulent foliage, and that the spores from the more recently developed spots are more likely to be deposited on the leaves, since they are more numerous. The life-cycle of these later spores may be more rapid by several days in the tender young leaves, in the moist, warm atmosphere.

If the above be correct, it should follow that July, or thereabouts, would show a wide-spread and sudden outbreak of the yellow disease-spots; and we know that such is the fact.

In August the leaves, destroyed by the abundant mycelium, fall in showers, the trees becoming in many cases almost stripped.

One set of observations may be recorded as typical of all the others *. A coloured ribbon having been loosely tied on a twig of the growing coffee, the development of the buds and leaves was carefully watched, and notes made of the changes which occurred from time to time as the latter passed from their earliest stages to adult age, and finally died off.

In the case which I will here cite, the terminal bud commenced to open about March 21st, and in a few days had developed a pair of shining, dark green, tightly apposed young leaves about $\frac{1}{4}$ inch long.

During the first three weeks in March, a continuance of dry, hot days caused all quick growth to cease; but the opening of the bud commenced at once after the showers which set in towards the end of March, and continued for the most part throughout April.

On April 2nd, in fact, after a week of showery growing-weather, the swollen bud had burst, and presented two leaves each $\frac{3}{4}$ inch long; and by April 25th these were fully formed, handsome bright-green structures, about $4\frac{1}{2}$ inches long by $2\frac{1}{4}$ inches broad in the middle. On or about this date the leaves ceased to enlarge, and may be considered adult and in full working order.

During the last week in April and the first week in May much rain fell in heavy showers; but from May 8th to May 25th a hot period intervened, the mornings being frequently close and steamy, however. At this time a few spots of "leaf-disease" were observable here and there on surrounding coffee-trees.

Now, from April 25th, the period at which we may consider the leaves adult, to June 1st no trace of *Hemileia* was discovered on either of the leaves; but on June 1st a distinct, though small "pin-spot" was seen on one of the leaves, which I shall call the left-hand leaf; and on June 3rd a few spores were seen proceeding from this. On the latter date also I found a minute yellow "pin-spot" on the right-hand leaf of the pair.

* For further evidence *cf.* Third Report.

The question is, What connexion had the weather, the presence of spores, and other circumstances with this definite appearance of two "leaf disease-spots" on leaves which had been to all appearance perfectly healthy from April 25th to June 1st, *i. e.* during some five weeks? It may first be stated that the weather from May 25th commenced to indicate the wet usually associated with the incoming of the south-west monsoon; and wind and rain prevailed more or less up to the end of June, June 20th to 26th, however, being fine.

The disease was first noticed on June 1st: if the "pin-spot" arose from the germination of a spore as I have described, this spore probably commenced its action within three weeks or so previously. On comparing the notes made about the requisite period, two points are clear:—1st, there were spores being shaken and blown about at that time; 2nd, it rained heavily up to May 8th, and a series of hot, close, steamy mornings occurred thereabouts; and it also rained during the week preceding the discovery of the spot. It is evident, in fact, that an odd spore of *Hemileia* germinated (probably in the dew) on each leaf on or about the 16th–18th of May, and sent its tube into the leaf to form the mycelium of which the presence was discovered on June 1st–3rd.

On June 15th the spot on the left-hand leaf was large and producing abundance of orange spores, which were being widely distributed by the high winds (from June 3rd to 15th), as well on surrounding trees and leaves as on other portions of the same leaf-surface.

On June 29th many more disease-spots were apparent for the first time: these rapidly came to produce spores, and on July 1st numbered 35 new patches, each pouring forth hundreds of spores to be distributed as usual. The spores which produced these probably germinated about June 15th, in the showers so prevalent during the month. By this time, also, the disease was bad all over the tree. I think it highly probable that the 35 new spots arose from spores detached from the one spot of June 3rd.

By July 6th the leaf was badly diseased—the one older spot (of July 3rd) beginning to turn brown in centre, but still active in spores; the others, which might be termed the second generation, shining through above with an orange hue.

On July 15th there appeared about 12 new spots, evidently from spores which germinated during the wet week preceding

July 1st. Each series of spots on the left-hand leaf could now be distinguished as follows:—One large and old spot, with a black patch in the centre, and few spores—that of June 3rd. A number (35) of very active spots which are just commencing to become brown in the centre—those of June 29th. A smaller number (12) of new active spots, and only just tinged yellow above—those of July 15th.

On July 23rd the leaf was evidently becoming destroyed by the numerous (48) virulent spots draining it, and curious green rings around the spots of June 29th alone represented the normal colour of the leaf; by July 26th these had faded, and the leaf was quite yellow and exhausted, and it fell during the night of that date.

As to the right-hand leaf, its history is very similar. On June 15th there were two *Hemileia*-spots on it, a new one having appeared in addition to that of June 3rd; on the 29th June appeared 57 new ones, which spread rapidly, and covered the greater part of the leaf by the 6th July; on July 15th were 13 still newer spots: the three generations were quite evident on July 27th, when the leaf was yellow. Before the last day of July this leaf also had fallen.

It is clear from the foregoing that what the planters term an "attack" of leaf-disease, *i. e.* a sudden outburst of the "rust," results from the coming to maturity at or about the same time of a series of mycelia which have been formed from the successful sowing of a certain number of spores; and since all were exposed to similar conditions, we must look for the origin of the rust to the conditions previously present. It is clear, however, that we cannot say exactly when a given disease-spot commenced to form; we can only argue from the known data. I do not think that any mycelium takes less than one week, or more than three weeks to form, as a rule, however; and hence the above argument may be widely applied.

Here appears direct proof of the cumulative power of the fungus. We cannot well doubt that the earliest spots on the leaves arose from odd spores blown by the wind from fallen leaves or other coffee-trees, and that these sowed their spores in turn, to produce spots in June, while further spores from the last-formed spots produced the July outbreak, and so on.

The above-recorded history of a pair of coffee-leaves may be summarized thus:—

About one month was occupied in forming the new leaves, a period during which they cannot be looked upon as very useful to the tree. During the next five weeks or so the leaves may be considered as normally active, *i. e.* they would during this period elaborate much material not used in constructing their own tissues, which would be passed down into the tree for the benefit of other portions.

After this, however, the disease-spots appeared; and the increasing mycelium would consume more and more of the elaborated materials until the leaf became exhausted and fell. This latter period must be one of struggle between the leaf-cells and the fungus-cells, and, especially towards the end of the time, the tree cannot derive much benefit from the devastated leaf-tissues. As here shown for a pair of leaves so with a whole tree—in proportion as the amount of fungus-mycelium increases the lease of life enjoyed by the leaves decreases, other things being, generally speaking, equal. This also I have proved by actual experiment and observation, by marking certain young trees and watching the results as they became badly affected with the disease.

Young trees were chosen because on such the development of the leaves takes place very nearly equally at all the branch-tips; hence one can be certain of comparing structures of equal value. Some healthy plants of *Coffea arabica* were two years old in June, when they were planted in the open in a sheltered hollow, at equal distances apart; at this time they had no disease, were not developing new leaves, and had lost but few. During August and September a typical plant was watched more particularly; and the following facts are true, especially for it, generally for the rest, since all the plants were equal and developed very similarly.

On Sept. 8 there were ten pairs of primary branches; a bud from the axil of each topmost leaf represented the eleventh primary. The foliage was dark green, fine, and healthy. Neighbouring coffee (to leeward) had lately suffered from virulent leaf-disease, and was still badly affected; but very few spots were apparent here.

The total number of leaves presented on this plant at the date given was 243; the number of cicatrices whence leaves had fallen amounted to 85. The terminal buds of the 11 branches represented 22 leaves *in posse*, and that of the main stem of course =2 leaves more, 24 in all. It is therefore clear that such a two-

year-old plant would possess about 350 leaves, if all were present. From data obtained by counting the leaves on a one-year-old plant, I find about 66 a common number, and on two-year-old plants about 250 to 260.

On Sept. 23 I carefully examined the young tree once more. 15 leaves present on Sept. 8 had now fallen, most of them diseased, and all among the oldest; and the terminal buds of the latter date had each produced its pair of leaves, which were still small however. We may therefore consider that the manufacturing capacity of the tree was little altered, if at all, by the replacement of 15 old leaves by 22 young ones; for although the latter could do little at present for the tree, the former could not be looked at as of much use either.

On Oct. 15 the tree, like its neighbours, was becoming badly "diseased," the yellow spots appearing on the leaves at all points. The actual number of leaves present =274; and of these 70 were young, and had been formed in the interval Sept. 23 to Oct. 15, while 46 leaves had fallen under the devastating action of *Hemileia*. Nevertheless, we may here well imagine that the 70 new leaves largely compensated the loss of 46 older ones; only, in comparing this remark with the statement before made, we must keep two facts before us—1st, the destroyed leaves in this case were more *directly* destroyed by the fungus; and 2nd, many spots, that is, masses of mycelium, were now present on the foliage yet on the tree.

On November 9 there were 254 leaves present; of these 46 were newly formed since October 15. In the interval 66 leaves had fallen, badly diseased.

On December 25 the disease had gained the mastery to a terrible extent; only 50 new leaves had been formed, whilst 107 had fallen victims. The actual number of leaves on the whole tree =197. Thus after little more than three months, during which period the tree had formed no less than 188 new leaves and lost 234, the total number of leaves present were fewer than at the commencement, although the *possible* leaf-bearing area was, of course, much increased during the interval. Moreover, these fewer leaves were to a great extent badly diseased. The experiment does not contradict what has been said as regards the seasons, since the trees were only planted out (and exposed to the wind-blown spores) in *June*.

Other facts come out if the above records be carefully studied.

It will be noted that the largest production of new leaves occurred in the interval Sept. 23 to Oct. 15: this corresponds to a period of rapid vegetative growth which then took place during moist, cloudy, and warm weather. After this, the rapidity of growth ceased as the air became drier towards the end of the year.

The greatest development of "leaf-disease," however, did not take place until the interval Nov. 9 to Dec. 25, *i. e.* about a month or six weeks later. This is in accordance with what is already known of the behaviour of the fungus, as, indeed, are all the details of this experiment.

It is now possible to understand the explanation of some difficulties which have been raised in objection to the generalizations presented in this and preceding publications on this subject.

One of the commonest popular difficulties freely expressed in connexion with the history of this and similar diseases of plants may be stated somewhat as follows:—It being proved that the fungus in the leaves causes the disease-spots to appear and the leaves to fall, how can such huge effects arise from such apparently small causes? The complete reply to this question would be a lengthy summary of our knowledge of the physiology of the leaf and its connexion with the life of the tree. It must be remembered that the mycelium of *Hemileia* not only robs the leaf of valuable materials, on the manufacture of which a large expenditure of energy was required, but it diverts the flow of nutritive substances. Moreover, in occupying space in the tissues of the plant, it prevents these tissues from fulfilling functions of service to the coffee-tree. To replace the damage done, the leaves would require either to do more work in a given time, or to have a longer lease of life to work in; whereas they have less opportunity of doing either. When the fungus is present in quantity there is less available substance sent down to the tree for the support of crop; and the life of the leaf is shortened. Hence the amount of fruit matured by the tree must be diminished unless one of two things happens—unless (1) more leaves are quickly formed and enabled to work for the benefit of the tree; or (2) more food-substances can be sent into the leaves and elaborated in the time allowed, so to speak, by the voracious pest. I have directly proved that the coffee-tree cannot produce crop if the leaves be stripped from its branches—a fact in accordance with what we otherwise know of similar cases.

By cultivation and proper manuring, it is conceivable that one

of the above-named effects could be produced; and, as a matter of experience, coffee-trees in richer soil, or better treated than others, may support more crop. This has given rise to another popular error with regard to "leaf-disease," that manuring &c. diminish or cure it.

I have elsewhere * discussed this at some length, and shown that the reason that manured or favourably situated coffee supports more crop is due to no direct action on the fungus at all (it is clear that circumstances which favour the host must rather benefit the parasite than otherwise), but that such trees support more crop because they can spare more food for that crop after paying the tax demanded by the fungus. Nay, it is certain that many trees support more crop and more fungus-mycelium at the same time than do others with which they are compared.

Closely connected with the above fallacy is another—that certain trees are "predisposed" to the disease or to infection. A refutation of this view has been matter of experiment: I have purposely waived all arguments from analogy, and tried to infect every description of plant—young and old, West-Indian and East-Indian, *Coffea arabica* and *C. liberica*; and there is no ground for supposing one more easily infected than another. This has nothing to do with the rapidity with which the mycelium produces the yellow spot. We have seen that a tender young leaf may succumb more rapidly (as a whole) than an older and more leathery one; and it must be evident that moisture, temperature, and other simple events may affect this.

We here face another difficulty, viz., Why do some trees suffer more than their neighbours? Let us shortly examine how complicated are the causes which aid in determining the amount of fungus-mycelium &c. on a coffee-tree. We may do this by assuming that two trees, side by side, are equally diseased. This involves one or the other of two comprehensive assumptions:—

Either (*a*) that the two trees were at the outset equal in all respects, that their root-masses, areas of leaf-surface, &c. were alike in extent and exposure, and that the relations of these to the soil, moisture, air, and light, &c. were equal in all respects—that equal quantities of food-materials were present in each, and that the expenditure and income connected with these remained equal in each case. It must be further assumed that each tree

* Third Report, 1881.

received at the outset the same *quotum* of disease-producing spores, which developed with equal energy and effect, and were equally related, actively and passively, in both examples.

Or (*b*), if the above formidable details and their consequences be not assumed, it must be admitted that the various complex relations between coffee and its surroundings on the one hand, and *Hemileia* and its environment on the other, though differing in details in all possible degrees, amounted to the same final result in the two cases selected—that, although both trees were dissimilarly related in mass, vigour, &c., and in their quantitative and other relations to earth, air, light, and the fungus, &c., yet they became "diseased" in the end to the same extent.

Either of the above assumptions would be rash in the extreme; and no argument in favour of the view that some trees are predisposed to the attacks of *Hemileia* can be logically based upon them.

As a summary of the foregoing, it may be fairly considered proved that "leaf-disease" here, as in so many other cases now known, is not antecedent to the fungus (*Hemileia*), but is consequent upon the injurious action of the mycelium; the "rust" and "disease-spots" are not mere signs of ill-health, due to obscure causes, but are preparatory stages in the spread of the disease-producing parasite. This being so, no ground exists for considering the fungus as a "product of vitiated plant-life" or "of the sap;" and just as little reason is there for the view that a sickly plant is prone to infection. Nay, experiments prove conclusively that a vigorous and healthy West-Indian tree is as easily infected as one from Ceylon; and it has also been shown that such a vigorous plant may produce more vigorous mycelium and spore-groups, *i. e.* it may disseminate more of the disease-producing fungus in a given period.

Those who have the necessary knowledge of the physiology of such a plant as coffee, and can appreciate the changes produced by a disturbing agent such as the parasite, will not fail to see a *vera causa* for "coffee-leaf disease" in the action of the fungus at many points for a long period.

It may be asked, "How came the rapid spread of this fungus?" The answer appears simply, having provided immense quantities of suitable food, carefully protected and preserved, man unconsciously offered just such conditions for the increase of this fungus as favour the multiplication of any organism whatever.

Whether any natural check to the further progress of this pest will arise is at present problematical, much as it may be desired from an economical point of view.

It may be remarked that, although careful trials have been repeatedly made, I have utterly failed to infect either the coffee-leaf or any other plant with the small "*sporidia*" produced by the germination of the *teleutospore* of *Hemileia*; no evidence exists for doubting that the reproduction of the fungus on coffee-estates takes place wholly by means of the innumerable *uredo-spores*, as described.

Several *Æcidia* (notably those on *Emilia*, *Tabernæmontana*, and *Pavetta*) have been experimented with, to observe whether their spores can be made to infect coffee. In no case has any positive result been obtained; and the obverse is also true—the *teleutospores* of *Hemeleia* did not infect the plants named. I hope that further trials will be made, however, with *Pavetta indica* and *P. angustifolia*: two *Æcidia* (*Æ. flavidum* and *Æ. Pavettæ*) have been described * on these hosts; and it is remarkable that the genus *Pavetta* stands somewhat closely allied to *Coffea*. As to the original source of this fungus, there can be no reasonable doubt of its antiquity †. Whether *Hemileia vastatrix* is more than a form of *H. Canthii*, moreover, must be considered at present undecided.

A List of published Species of Cape Orchideæ.

By HARRY BOLUS, F.L.S. ‡

[Read May 4, 1882.]

THE literature of Cape Orchidology is so scattered that the student is beset with difficulties at the outset in the attempt to ascertain what has been already described. Since Lindley's 'Genera and Species of Orchidaceous Plants' (1830–40), there has been no attempt at a general list. Many subsequent additions have been made, chiefly to the flora of the Eastern Region; and there are still many unpublished species from Kaffraria,

* Messrs. Berkeley and Broome, in Journ. Linn. Soc., Bot. vol. xiv.

† As first suggested, I believe, by Mr. Thiselton Dyer.

‡ See paper "Notes on some Cape Orchids," and footnote *antea*, p. 233.

Natal, the Orange Free State, and the Transvaal Republic. The present is to be regarded as a preliminary attempt only. I have consulted all the more probable sources of information, but some species may still lie hidden in continental serials or the transactions of learned societies; but I do not think there are many. In the arrangement of the tribes, subtribes, and genera I have followed Mr. Bentham's revision, generally, as sketched in the Journal of this Society, vol. xviii. pp. 281–360. With regard, however, to certain genera of the subtribe *Diseæ*, such as *Herschelia*, *Penthea*, *Monadenia*, &c., Mr. Bentham's final views, I understand, have not yet been expressed. I have cited all synonyms, except those of mere lists (such as Thunberg's 'Prodromus Plantarum Capensium'), and all figures so far as known to me.

Tribe EPIDENDREÆ.

Subtribe LIPARIDEÆ.

LIPARIS, *Rich. Orch. Eur.* 30, f. 10.
(Sturmia, *Reichb.*)

1. L. CAPENSIS, *Lindl. in Ann. Nat. Hist.* ii. (1840), 314.
 Sturmia capensis, *Sond. Linnæa*, xix. 71.
2. L. BOWKERI, *Harv. Thesaurus Capensis*, ii. p. 6, t. 109.

Tribe VANDEÆ.

Subtribe EULOPHIEÆ.

EULOPHIA, *R. Br. Bot. Reg.* t. 686.

1. E. PLICATA.
 Satyrium aculeatum ?, *Linn. Suppl.* p. 402; *Syst. Veg.* xiv. 811.
 Cymbidium aculeatum, *Thunb. Flor. Cap. ed. Schultes*, p. 27.
 Satyrium tabulare ?, *Linn. Suppl.* p. 403.
 Cymbidium tabulare ?, *Thunb. Fl. Cap.* 27.
 Cymbidium plicatum, *Harv. Comp. Bot. Mag.* ii. 203; *Hook. Icon. Plant.* t. 104.
2. E. CAPENSIS.
 Satyrium capense, *Linn. Am. Acad.*, *Pl. Afr.* n. 93.
 Satyrium pedicellatum, *Linn. Suppl.* 402.
 Cymbidium pedicellatum, *Sw. Schrad. Diar.* (1799), 24; *Thunb. Fl. Cap.* 27; *denuo descr. a Reichb. f. Linnæa*, xx. 675.
 Cyrtopera pedicellata, *Lindl. Gen. Sp. Orch.* 190.

3. E. ENSATA, *Lindl. Bot. Reg.* t. 1147.
4. E. TRISTIS, *Spreng. Syst. Veg.* iii. 720.
Satyrium triste, *Linn. Suppl.* 402.
Limodorum triste, *Thunb. Fl. Cap.* 29.
5. E. LAMELLATA, *Lindl. Gen. Sp. Orch.* 184.
6. E. MICRANTHA, *Lindl. Gen. Sp. O.* 184.
7. E. BARBATA, *Spreng. Syst. Veg.* iii. 720.
Serapias capensis, *Linn. Mantiss.* 293.
Limodorum barbatum, *Thunb. Fl. Cap.* 29.
8. E. PARVILABRIS, *Lindl. Comp. Bot. Mag.* ii. 201.
9. E. CLAVICORNIS, *Lindl. l. c.* 202.
10. E. EMARGINATA, *Lindl. l. c.* 202.
11. E. OVALIS, *Lindl. l. c.* 202.
12. E. COCHLEARIS, *Lindl. l. c.* 202.
13. E. FOLIOSA.
Cyrtopera foliosa, *Lindl. l. c.* 204.
14. E. DRÈGEANA, *Lindl. l. c.* 202.
15. E. PLATYPETALA, *Lindl. l. c.* 202.
16. E. LISSOCHILOIDES, *Lindl. l. c.* 203.
17. E. SPHÆROCARPA, *Sond. Linnæa*, xix. 73.
18. E. ZEYHERIANA, *Sond. l. c.* 73.
19. E. COMOSA, *Sond. l. c.* 72.
20. E. NUTANS, *Sond. l. c.* 73.
21. E. ODONTOGLOSSA, *Reichb. f. Linnæa*, xix. 373, xx. 684.
22. E. MELEAGRIS, *Reichb. f. l. c.* xx. 683.
23. E. VIOLACEA, *Reichb. f. l. c.* 683.
24. E. TENELLA, *Reichb. f. l. c.* 681.
25. E. RUPESTRIS, *Reichb. f. l. c.* 682.

LISSOCHILUS, *R. Br. in Lindl. Coll. Bot.* t. 31.

1. L. SPECIOSUS, *R. Br. l. c.*, *Bot. Reg.* t. 573.
2. L. PARVIFLORUS, *Lindl. Gen. Sp. O.* 191.
3. L. STREPTOPETALUS, *Lindl. Comp. Bot. Mag.* ii. 204; *Bot. Reg.* t. 1002.
4. L. ÆQUALIS, *Lindl. l. c.* ii. 204.
5. L. PLATYPETALUS, *Lindl. l. c.* 204.
6. L. CLITELLIFER, *Reichb. f. Linnæa*, xx. 687.
7. L. KREBSII, *Reichb. f. l. c.* 685; *Bot. Mag.* t. 5861.

Subtribe Cymbidieæ.

Cymbidium, *Swartz, Nov. Act. Ups.* vi. 70.

1. C. Sandersonii, *Harv.* (*MSS.*?).

Polystachya, *Hook. Exot. Fl.* 103.

(Epiphora, *Lindl. Comp. Bot. Mag.* ii. 101.)

1. P. Gerrardi, *Harv. Thes. Cap.* ii. 49, t. 176.
2. P. Sandersoni, *Harv. l. c.* t. 177.
3. P. capensis, *Sond. in Hb. Eckl. & Zey.*; *Harv. l. c.* 50, t. 179.
4. P. pubescens, *Reichb. f. Walp. Ann.* (1863), vi. 643; *Bot. Mag.* t. 5586.

   P. Lindleyana, *Harv. l. c.* (1863), p. 50, t. 178.
   Epiphora pubescens, *Lindl. Comp. Bot. Mag.* ii. 101.
5. P. similis, *Reichb. f. Otia bot. Hamburg.* 112.

Subtribe Sarcantheæ.

Angræcum, *Petit-Thouars, Orch. Afr.*

1. A. arcuatum, *Lindl. l. c.* 204; *Harv. Thes. Cap.* t. 107.
2. A. bicaudatum, *Lindl. l. c.* 205; *Harv. l. c.* t. 108.
3. A. "n. sp.," *Lindl. l. c.* 205 (*Drège*, 8269).
4. A. conchiferum, *Lindl. l. c.* 205.
5. A. sacciferum, *Lindl. l. c.* 205.
6. A. pusillum, *Lindl. l. c.* 205.
7. A. chiloschistæ, *Reichb. f. Linnæa*, xx. 678.
8. A. Mystacidii, *Reichb. f. l. c.* 677.

Mystacidium, *Lindl. Comp. Bot. Mag.* ii. 206.

1. M. filicorne, *Lindl. l. c.* 206; *Harv. Thes. Cap.* t. 175.

   Epidendrum capense, *Linn. Suppl.* 407.
   Limodorum longicorne, *Swartz in Schrad. Diar.* (1799), p. 230.
   Angræcum capense, *Lindl. Gen. Sp. O.* 248.
   Æranthus filicornis, *Reichb. f. in Walp. Ann.* vi. 900.
2. M. pusillum, *Harv. Thes. Cap.* ii. 47, t. 173.
3. M. gracile, *Harv. l. c.* ii. 48, t. 174.

Tribe OPHRYDEÆ.

Subtribe Habenarieæ.

Herminium, *R. Br. Hort. Kew.* ed. 2.

1. H. natalense, *Reichb. f. Otia bot. Hamburg.* 108.

STENOGLOTTIS, *Lindl. Comp. Bot. Mag.* ii. 210.

1. S. FIMBRIATA, *Lindl. l. c.*; *Harv. Thes. Cap.* t. 56.

BARTHOLINA, *R. Br. Hort. Kew.* ed. 2, v. 194. (Lathrisia, *Sw.*)

1. B. PECTINATA, *R. Br. l. c.*; *Bot. Reg.* xx. t. 1653.
Orchis pectinata, *Thunb. Flor. Cap.* 15.
Orchis Burmanniana, *Linn. Suppl.* 1334.
B. Burmanniana, *Ker in Brande's Journ.* iv. 204, t. 5.
Arethusa ciliaris, *Linn. Suppl.* 405.

HUTTONIA, *Harv. Thes. Cap.* ii. 1. (Hallackia, *Harv. l. c.*)

1. H. PULCHRA, *Harv. l. c.* t. 101.
2. H. HALLACKII.
Hallackia fimbriata, *Harv. l. c.* ii. t. 102.

HOLOTHRIX, *L. C. Rich. Annot.* 83.
(Saccidium, *Lindl.*; Monotris, *Lindl.*; Bucculina, *Lindl.*; Scopularia, *Lindl.*; Tryphia, *Lindl.*)

1. H. PARVIFOLIA, *Lindl. Gen. Sp. Orch.* 283; *Hook. Ic. Plant.* t. 103 B.
2. H. EXILIS, *Lindl. l. c.* 283.
3. H. SQUAMULOSA, *Lindl. Comp. Bot. Mag.* ii. 206.
4. H. HARVEIANA, *Lindl. l. c.*; *Hook. Ic. Plant.* t. 103 A.
5. H. VILLOSA, *Lindl. l. c.*
6. H. GRACILIS, *Lindl. l. c.*
7. H. INCURVA, *Lindl. l. c.*
8. H. BURCHELLII, *Reichb. f. Otia bot. Hamburg.* 119.
Scopularia Burchellii, *Lindl. Gen. Sp. Orch.* 303.
9. H. GRANDIFLORA, *Reichb. f. l. c.* 119.
Scopularia grandiflora, *Sond. Linnæa,* xix. 79.
10. H. SCOPULARIA, *Reichb. f. l. c.* 119.
Scopularia secunda, *Lindl. Comp. Bot. Mag.* ii.
11. H. MONOTRIS, *Reichb. f. l. c.* 119.
Monotris secunda, *Lindl. Gen. Sp. Orch.* 303.
12. H. ASPERA, *Reichb. f. l. c.* 119.
Bucculina aspera, *Lindl. Comp. Bot. Mag.* ii. 209.
13. H. LINDLEYANA, *Reichb. f. l. c.* 119.
Tryphia secunda, *Lindl. l. c.*; *Harv. Thes. Cap.* ii. t. 105.
14. H. PARVIFLORA, *Reichb. f. l. c.* 119.
Tryphia parviflora, *Lindl. l. c.*
15. H. ORTHOCERAS, *Reichb. f. l. c.* 119.
Tryphia orthoceras, *Harv. Thes. Cap.* ii. 4, t. 105.

16. H. PILOSA, *Reichb. f. l. c.* 119.
Saccidium pilosum, *Lindl. Gen. Sp. O.* 301.
17. H. BRACHYLABRIS, *Sond. Linnæa*, xix. 78.
18. H. CONDENSATA, *Sond. l. c.* 76.
19. H. MUNDTII, *Sond. l. c.* 77.
20. H. SECUNDA, *Reichb. f. l. c.* 119.
Orchis secunda, *Thunb. Flor. Cap.* 6.
Tryphia major, *Sond. l. c.* 82.
21. H. MACOWANIANA, *Reichb. f. l. c.* 108.

HABENARIA, *Willd. Sp. Pl.* iv. 44.

1. H. ARENARIA, *Lindl. Gen. Sp. O.* 318; *Harv. Thes. Cap.* t. 55.
2. H. FALCIFORMIS.
Bilabrella falciformis, *Bot. Reg.* t. 1701.
Bonatea bilabrella, *Lindl. Gen. Sp. O.* 328.
3. H. TETRAMERA.
Bonatea tetrapetala, *Lindl. Comp. Bot. Mag.* ii. 208.
4. H. CLAVATA.
Bonatea clavata, *Lindl. l. c.*
5. H. CASSIDEA, *Reichb. f. in Walp. Ann. Bot.* i. 797.
Bonatea cassidea, *Sond. Linnæa*, xix. 81.
6. H. DENSIFLORA, *Reichb. f. l. c.*
Bonatea densiflora, *Sond. l. c.* 80.
7. H. ORNITHOPODA, *Reichb. f. Linnæa*, xx. 696.
8. H. SAUNDERSIÆ, *Harv. Thes. Cap.* ii. t. 147.
Bonatea Darwinii, *Weale in Journ. Linn. Soc.* x. p. 470.
9. H. NATALENSIS, *Reichb. f. Otia bot. Hamb.* 97.
10. H. POLYPODANTHA, *Reichb. f. l. c.* 97.
11. H. MALACOPHYLLA, *Reichb. f. l. c.* 97.
12. H. GERRARDI, *Reichb. f. l. c.* 97.
13. H. ORANGANA, *Reichb. f. l. c.* 101.
14. H. DRÈGEANA, *Lindl. in Ann. Nat. Hist.* iv. (1840), 310.
15. H. CILIOSA, *Lindl. l. c.* 314.
16. H. LÆVIGATA, *Lindl. l. c.* 315.

BONATEA, *Willd. Sp. Plant.* iv. 43.

1. B. SPECIOSA, *Willd. l. c.*; *Bot. Mag.* t. 2926; *Lodd. Cab.* t. 284.
Orchis speciosa, *Linn. Suppl.* 401; *Thunb. Fl. Cab.* 27.
2. B. FOLIOSA, *Lindl. Gen. Sp. O.* 329.
Orchis foliosa, *Sw. Act. Holm.* (1800), 206.
3. B. BOLTONI, *Harv. Thes. Cap.* i. 55, t. 88.

Subtribe Diseæ.

Satyrium, *Swartz, Act. Holm.* (1800), 214.

(Satyridium, *Lindl.*; Aviceps, *Lindl.*)

1. S. membranaceum, *Sw. l. c.* 216.
2. S. longicolle, *Lindl. Gen. Sp. O.* 335.
3. S. carneum, *R. Br. Hort. Kew.* ed. 2, v. 196; *Bot. Mag.* t. 1512; *Fl. des Serres*, t. 329.
4. S. parviflorum, *Sw. l. c.* 216.
   Orchis bicornis, *Jacq. Hort. Schœnbr.* t. 179.
   Diplectrum parviflorum, *Pers. Syn.* ii. 509.
5. S. stenopetalum, *Lindl. Gen. Sp. O.* 336.
6. S. foliosum, *Sw. l. c.* 216.
7. S. sphærocarpum, *Lindl. l. c.* 337.
8. S. maculatum, *Burch. in Lindl. l. c.* 337.
9. S. longicauda, *Lindl. l. c.* 337.
10. S. macrophyllum, *Lindl. l. c.* 338.
11. S. lupulinum, *Lindl. l. c.* 338.
12. S. cucullatum, *Thunb. Fl. Cap.* 17; *Bot. Reg.* t. 416; *Lodd. Cab.* t. 104.
    Orchis bicornis, *Linn. Sp. Pl.* 1330 (*non Jacq.*); *Bot. Repos.* t. 315.
13. S. candidum, *Lindl. Bot. Reg.* (1838), *Misc.* no. 153.
14. S. acuminatum, *Lindl. Gen. Sp. O.* 339.
15. S. humile, *Lindl. l. c.* 339.
16. S. densiflorum, *Lindl. l. c.* 340.
17. S. erectum, *Thunb. Flor. Cap.* 16; *Maund. Bot.* iii. t. 117.
18. S. pustulatum, *Lindl. Bot. Reg.* (1840), t. 18; *Bauer's Illustr.* t. 14.
    S. papillosum, *Lindl.* (sphalmate), *Gen. Sp. O.* 341.
19. S. cassideum, *Lindl. Gen. Sp. O.* 341.
20. S. coriifolium, *Swartz, Act. Holm.* (1800), 216; *Bot. Mag.* t. 2172; *Bot. Reg.* t. 703.
    S. cucullatum, *Lindl. Lodd. Bot. Cab.* t. 104.
21. S. ligulatum, *Lindl. Gen. Sp. O.* 342.
22. S. militare, *Lindl. l. c.* 342.
23. S. eriostomum, *Lindl. l. c.* 342.
24. S. bracteatum, *Thunb. Flor. Cap.* 18.
    Ophrys bracteata, *Linn. Suppl.* 403.
25. S. retusum, *Lindl. l. c.* 343.

26. S. BICALLOSUM, *Swartz, l. c.* 216.
27. S. LINEATUM, *Lindl. Gen. Sp. O.* 344.
S. bracteatum, *Ker in Brande's Journal*, viii. 221, t. 3.
28. S. PICTUM, *Lindl. Gen. Sp. O.* 344.
29. S. CORDIFOLIUM, *Lindl. Gen. Sp. O.* 344.
30. S. MUTICUM, *Lindl. Gen. Sp. O.* 344.
31. S. RHYNCHANTHUM.
Satyridium rostratum, *Lindl. Gen. Sp. O.* 345; *Harv. Thes. Cap.* t. 87.
32. S. PUMILUM, *Thunb. Flor. Cap.* 19.
Aviceps pumila, *Lindl. Gen. Sp. O.* 345.
33. S. CRISTATUM, *Sond. Linnæa*, xix. 84.
34. S. UTRICULATUM, *Sond. l. c.* 84.
35. S. ODORUM, *Sond. l. c.* 86.
36. S. PYGMÆUM, *Sond. l. c.* 86.

PACHITES, *Lindl. Gen. Sp. O.* 301.

1. P. APPRESSA, *Lindl. Gen. Sp. O.* 301.

DISA, *Linn. Suppl.*; *Swartz, Act. Holm.* (1800), 208.

(Penthea, *Lindl. Nat. Syst. Bot.* ed. ii. p. 446.

1. D. GRANDIFLORA, *Linn. Suppl.* 406; *Bot. Reg.* t. 926; *Lindl. Sert. Orch.* t. 49; *Bot. Mag.* t. 4073; *Fl. des Serres*, ii. t. 160.
D. uniflora, *Berg. Fl. Cap.* 348, t. 4. f. 7.
2. D. SECUNDA, *Sw. l. c.* 210.
D. racemosa, *Linn. Suppl.* 406.
3. D. CRASSICORNIS, *Lindl. Gen. Sp. O.* 348.
4. D. GRACILIS, *Lindl. Gen. Sp. O.* 348.
5. D. CHRYSOSTACHYA, *Sw. l. c.*
6. D. POLYGONOIDES, *Lindl. Gen. Sp. O.* 349; *Bot. Mag.* t. 6532.
7. D. CORNUTA, *Sw. l. c.*; *Bot. Mag.* t. 4091.
Orchis cornuta, *Linn. Sp. Pl.* 1330.
8. D. MACRANTHA, *Thunb. Fl. Cap.* 8.
9. D. MEGACERAS, *Hook. f. Bot. Mag.* t. 6529.
10. D. LONGIFOLIA, *Lindl. Gen. Sp. O.* 349.
11. D. LONGICORNIS, *Linn. f. Suppl.* 406; *Thunb. Fl. Cap.* 8; *Lam. Encycl.* t. 727.
12. D. FASCIATA, *Lindl. Gen. Sp. O.* 350; *Harv. Thes. Cap.* t. 85.
13. D. ROSEA, *Lindl. Gen. Sp. O.* 350.

14. D. SAGITTALIS, *Sw. l. c.*; *Thunb. Fl. Cap.* 9.
Orchis sagittalis, *Linn. Suppl.* 399.
15. D. ATTENUATA, *Lindl. Gen. Sp. O.* 351.
16. D. TRILOBA, *Lindl. Gen. Sp. O.* 351.
17. D. GLANDULOSA, *Burch. in Lindl. Gen. Sp. O.* 351.
18. D. VENOSA, *Sw. l. c.*; *Thunb. Flor. Cap.* 15.
Orchis tripetaloides, *Linn. Suppl.* 398.
19. D. CAULESCENS, *Lindl. Gen. Sp. O.* 351.
20. D. NERVOSA, *Lindl. Gen. Sp. O.* 352.
21. D. DRACONIS, *Sw. l. c.*; *Thunb. Fl. Cap.* 10.
Orchis Draconis, *Linn. Suppl.* 400.
22. D. HARVEIANA, *Lindl. in Hook. Lond. Journ. Bot.* (1842), i. 15.
23. D. GLADIOLIFLORA, *Burch. in Lindl. Gen. Sp. O.* 352.
24. D. PORRECTA, *Sw. l. c.*; *Ker in Brande's Journ.* v. t. 5.
D. ferruginea, *Thunb. Flor. Cap.* 11; *Hook. Icon. Plant.* t. 214.
25. D. ZEYHERI, *Sond. Linnæa*, xix. 95.
26. D. SPATHULATA, *Sw. l. c.*; *Thunb. Flor. Cap.* 15; *Bauer's Illustr. Gen.* t. xiv.; *Harv. Thes. Cap.* t. 86.
27. D. TRIPARTITA, *Lindl. Gen. Sp. O.* 353.
?28. ? D. MULTIFIDA, *Lindl. Gen. Sp. O.* 353.
29. D. PROPINQUA, *Sond. Linnæa*, xix. 95.
30. D. CHARPENTIERIANA, *Reichb. f. Linnæa*, xx. 688.
31. D. ATROPURPUREA, *Sond. Linnæa*, xix. 96.
32. D. BRACTEATA, *Sw. l. c.*; *Bot. Reg.* t. 324.
33. D. TENUIS, *Lindl. Gen. Sp. O.* 354.
34. D. TENELLA, *Thunb. Flor. Cap.* 11.
Orchis tenella, *Linn. Suppl.* 400.
35. D. BRACHYCERAS, *Lindl. Gen. Sp. O.* 355.
36. D. OBTUSA, *Lindl. Gen. Sp. O.* 355.
? D. picta, *Sond. Linnæa*, xix. 99.
? D. tabularis, *Sond. l. c.* 99.
? D. neglecta, *Sond. l. c.* 99.
? D. maculata, *Harv. Hook. Lond. Journ. Bot.* (1842), i. 15.
37. D. TELIPOGONIS, *Reichb. f. Linnæa*, xx. 689.
38. D. STRICTA, *Sond. Linnæa*, xix. 91.
39. D. ACONITOIDES, *Sond. Linnæa*, xix. 91; *Harv. Thes. Cap.* t. 41.
40. D. CAPRICORNIS, *Reichb. f. l. c.* 692.
41. D. SCHIZODIOIDES, *Sond. l. c.* 92.
42. D. PATULA, *Sond. l. c.* 94.

43. D. VAGINATA, *Harv. in Hook. Lond. Journ. Bot.* (1842), i. 15.
? D. modesta, *Reichb. f. l. c.* 670.
44. D. OVALIFOLIA, *Sond. l. c.* 93.
45. D. PULCHRA, *Sond. l. c.* 94.
46. D. MONTANA, *Sond. l. c.* 90.
47. D. SANGUINEA, *Sond. l. c.* 97.
48. D. LEPTOSTACHYS, *Sond. l. c.* 98.
49. D. NATALENSIS, *Harv. l. c.* 16.
50. D. RICHARDIANA, *Lehm. ex Lindl. Gen. Sp. O.* 361.
Penthea obtusa, *Lindl. l. c.* 361.
51. D. FILICORNIS, *Thunb. Flor. Cap.* 17.
Disa patens, *Sw. l. c.* 214, *nec Thunb.*
Orchis filicornis, *Linn. Suppl.* 400.
Penthea filicornis, *Lindl. Gen. Sp. O.* 361.
52. D. REFLEXA.
Penthea reflexa, *Lindl. Gen. Sp. O.* 361.
53. D. PATENS, *Thunb. Flor. Cap.* 16, *nec Sw.*
Ophrys patens, *Linn. Suppl.* 404.
Disa tenuifolia, *Sw. l. c.* 214.
Penthea patens, *Lindl. Gen. Sp. O.* 362.
54. D. MINOR.
Penthea minor, *Sond. l. c.* 104.
55. D. PARVILABRIS.
Penthea triloba, *Sond. l. c.* 104.
56. D. MELALEUCA, *Thunb. Flor. Cap.* 16; *Harv. Thes. Cap.* t. 84.
Ophrys bivalvata, *Linn. Suppl.* 403.
Penthea melaleuca, *Lindl. Gen. Sp. O.* 361.
57. D. ATRICAPILLA.
Penthea atricapilla, *Harv. Lond. Journ. Bot.* (1842), i. 17.
58. D. HUTTONII, *Reichb. f. Otia bot. Hamb.* 105.
59. D. HEMISPHÆROPHORA, *Reichb. f. l. c.* 106.
60. D. MACOWANI, *Reichb. f. l. c.* 106.
61. D. CEPHALOTES, *Reichb. f. l. c.* 106.
62. D. LÆTA, *Reichb. f. l. c.* 106.

HERSCHELIA, *Lindl. Gen. Sp. O.* 362.

1. H. CŒLESTIS, *Lindl. l. c.* 363.
Disa graminifolia, *Ker in Brande's Journ.* vi. 44, t. 1.
2. H. BARBATA, *Bolus, anteà*, p. 236.
Disa barbata, *Sw. l. c.*; *Lindl. Gen. Sp. O.* 354.
Orchis barbata, *Linn. Suppl.* 399.

MONADENIA, *Lindl. Gen. Sp. O.* 356.

1. M. RUFESCENS, *Lindl. l. c.* 356.
   Disa rufescens, *Sw. l. c.* 210; *Thunb. Flor. Cap.* 13.
2. M. BREVICORNIS, *Lindl. l. c.* 357.
3. M. MICRANTHA, *Lindl. l. c.* 357.
4. M. DENSIFLORA, *Lindl. l. c.* 357.
5. M. MACROSTACHYA, *Lindl. l. c.* 357.
6. M. MACROCERA, *Lindl. l. c.* 358.
7. M. OPHRYDEA, *Lindl. l. c.* 358.
8. M. PRASINATA, *Lindl. l. c.* 358.
   Disa prasinata, *Ker, Bot. Reg.* t. 210.
9. M. LEPTOSTACHYA, *Sond. Linnæa,* xix. 101.
10. M. INFLATA, *Sond. l. c.* 102.
   ? Disa physodes, *Thunb. Flor. Cap.* 12.
11. M. MULTIFLORA, *Sond. l. c.* 101.
12. M. LANCIFOLIA, *Sond. l. c.* 100.
13. M. COMOSA, *Reichb. f. Linnæa,* xx. 687.

SCHIZODIUM, *Lindl. Gen. Sp. O.* 358.

1. S. FLEXUOSUM, *Lindl. l. c.* 359.
   Disa flexuosa, *Sw. l. c.* 212; *Thunb. Flor. Cap.* 9.
   Orchis flexuosa, *Linn. Sp. Pl.* 1331.
2. S. ARCUATUM, *Lindl. l. c.* 359.
3. S. LONGIPETALUM, *Lindl. l. c.* 359.
4. S. OBTUSATUM, *Lindl. l. c.* 359.
5. S. OBLIQUUM, *Lindl. l. c.* 359.
6. S. CLAVIGERUM, *Lindl. l. c.* 360.
7. S. RIGIDUM, *Lindl. l. c.* 360.
8. S. INFLEXUM, *Lindl. l. c.* 360.
9. S. GUEINZII, *Reichb. f. Linnæa,* xx. 694.

BROWNLEEA, *Lindl. Hook. Lond. Journ. Bot.* (1842), i. 16.

1. B. CÆRULEA, *Harv. Hook. Lond. Journ. Bot.* (1842), i. 16; *Harv. Thes. Cap.* ii. 106, t. 103.
   B. macroceras, *Sond. Linnæa,* xix. 106.
2. B. PARVIFLORA, *Harv. l. c.* 16.
3. B. RECURVATA, *Sond. l. c.* 107; *Harv. Thes. Cap.* t. 104.

FORFICARIA, *Lindl. Gen. Sp. O.* 362.

1. F. GRAMINIFOLIA, *Lindl. l. c.* 362.

BRACHYCORYTHIS, *Lindl. Gen. Sp. O.* 363.

1. B. OVATA, *Lindl. l. c.*; *Harv. Thes. Cap.* i. t. 53.
2. B. PUBESCENS, *Harv. Thes. Cap.* i. 35, t. 54.
3. B. TENUIOR, *Reichb. f. Otia bot. Hamb.* 104.
4. B. MACOWANIANA, *Reichb. f. l. c.* 104.

SCHIZOCHILUS, *Sond. Linnæa*, xix. 78.

1. S. ZEYHERI, *Sond. l. c.*

Subtribe CORYCIEÆ.

PTERYGODIUM, *Swartz, Act. Holm.* (1800), 217.

(Ommatodium, *Lindl. Gen. Sp. O.* 365.)

1. P. PLATYPETALUM, *Lindl. l. c.* 366.
2. P. CATHOLICUM, *Sw. l. c.*; *Thunb. Flor. Cap.* 22; *Brande's Journ.* vi. t. 1. f. 3.
   Ophrys catholica, *Linn. Am. Acad., Pl. Afr.* n. 94.
   O. alaris, *Linn. Suppl.* 404.
3. P. ACUTIFOLIUM, *Lindl. Gen. Sp. O.* 366.
4. P. ALATUM, *Sw. l. c.*; *Thunb. Fl. Cap.* 24; *Brande's Journ.* viii. t. 3.
5. P. CAFFRUM, *Sw. l. c.*; *Thunb. l. c.*
6. P. CARNOSUM, *Lindl. Gen. Sp. O.* 367.
7. P. VENOSUM, *Lindl. l. c.* 367; *Harv. Thes. Cap.* t. 94.
8. P. INVERSUM, *Sw. l. c.*; *Thunb. l. c.*; *Brande's Journ.* ix. t. 4.
9. P. CRUCIFERUM, *Sond. Linnæa*, xix. 109.
10. P. VOLUCRIS, *Sw. l. c.* 218; *Thunb. Fl. Cap.* 22; *Ker, Brande's Journ.* ix. t. 4.
    Ophrys Volucris, *Linn. Suppl.* 403.
    Ommatodium Volucris, *Lindl. Gen. Sp. O.* 365.

DISPERIS, *Swartz, Act. Holm.* (1800), 218.

1. D. CAPENSIS, *Sw. l. c.*; *Thunb. Flor. Cap.* 25; *Ker in Brande's Journ.* v. t. 1. f. 2.
   Arethusa capensis, *Linn. Suppl.* 405.
   Disperis tenera, *Spreng.*
2. D. SECUNDA, *Sw. l. c.*; *Thunb. Fl. Cap.* 26; *Ker, l. c.* v. t. 1. f. 3.
   Orchis circumflexa, *Linn. Sp. Pl.* 1344.
3. D. MICRANTHA, *Lindl. Gen. Sp. O.* 370.
4. D. VILLOSA, *Sw. l. c.*; *Thunb. l. c.* 25; *Ker, l. c.* vi. t. 1. f. 5.
   Arethusa villosa, *Linn. Suppl.* 403.

5. D. CUCULLATA, *Sw. l. c.*; *Ker, l. c.* vi. t. 1. f. 4.
6. D. PALUDOSA, *Harv. Hook. Lond. Journ. Bot.* (1842), i. 14; *Harv. Thes. Cap.* t. 148.
7. D. CARDIOPHORA, *Harv. Thes. Cap.* ii. 4, t. 106.
8. D. FANNINIÆ, *Harv. l. c.* ii. 46, t. 171.
9. D. COOPERI, *Harv. l. c.* ii. 47, t. 172.
10. D. PURPURATA, *Reichb. f. Linnæa*, xli. 55.
11. D. STENOPLECTRON, *Reichb. f. Otia bot. Hamb.* 102.
12. D. WEALII, *Reichb. f. l. c.* 103.

CORYCIUM, *Swartz, Act. Holm.* (1800), 220.

1. C. CRISPUM, *Sw. l. c.*; *Thunb. Flor. Cap.* 21.
Orchis coccinea, *Buxb. Cent.* iii. p. 7, t. 11.
2. C. BICOLOR, *Sw. l. c.*; *Thunb. l. c.* 21; *Ker in Brande's Journ.* vi. t. 1. f. 1; *Bauer's Illustr. Gen.* t. 15.
3. C. EXCISUM, *Lindl. Gen. Sp. O.* 368.
4. C. MICROGLOSSUM, *Lindl. l. c.* 369.
5. C. OROBANCHOIDES, *Sw. l. c.*; *Thunb. l. c.* 20; *Ker, l. c.* viii. t. 3. f. 3?; *Lindl. Bot. Reg.* t. 45.
Satyrium orobanchoides, *Linn. Suppl.* 402.
6. C. VESTITUM, *Sw. l. c.*; *Thunb. l. c.* 21.
7. C. BIFIDUM, *Sond. Linnæa*, xix. 111.
C. ligulatum, *Reichb. f. l. c.* xix. 375.
8. C. NIGRESCENS, *Sond. l. c.* 120.

CERATANDRA, *Lindl. Gen. Sp. O.* 363.

1. C. CHLOROLEUCA, *Mundt in herb. Eckl.*; *Bauer's Illustr. Gen.* t. xvi.
Pterygodium atratum, *Sw. Act. Holm.* (1800), 217.
Ophrys atrata, *Linn. Mant.* 121.
2. C. AURICULATA, *Lindl. l. c.* 364.
3. C. GLOBOSA, *Lindl. l. c.* 364.
4. C. PARVIFLORA, *Lindl. l. c.* 364.
5. C. GRANDIFLORA, *Lindl. l. c.* 364.
6. C. HARVEYANA, *Lindl. l. c.* 365.
7. C. AFFINIS, *Sond. Linnæa*, xix. 108.

SUMMARY.

	Genera.	Species.
EPIDENDREÆ	1	2
VANDEÆ	6	49
OPHRYDEÆ	21	214
Total	28	265

Notes on the Life-History of a Crocus, and the Classification and Geographical Distribution of the Genus. By GEORGE MAW, F.L.S.

[Read January 19, 1882.]

(PLATES XXXIV. & XXXV.)

As a preliminary to my forthcoming 'Monograph of the Genus *Crocus*,' it has been suggested to me that I should communicate to the Linnean Society a short paper, as a sort of summary of the main points bearing on the life-history, the classification, and the geographical distribution of the genus.

The Corm.—Commencing with the life-history, it will be convenient to first consider the corm during the short period of its rest, at about the latter end of July, intervening between the dying away of the vernal foliage and the commencement of the ensuing season's growth. Although a Crocus-corm seems to enjoy a long period of lifeless repose under ground, the actual time of rest may be counted by days rather than by weeks or months; for scarcely has the life-course of one season ended than the new growth of the ensuing season commences.

Every living part of a Crocus is annually reproduced; and in one sense there is no continuity of life within each organ. The corm-tunic is the only permanent record of perennial existence; and even this, in its living state, lasts but a year.

The corm, newly matured and at rest, is in form an irregular spheroid, varying much in its size and proportions in different species, and ranging from $\frac{1}{4}$ of an inch to $1\frac{1}{2}$ inch in diameter; it is depressed both at its apex and base. It consists of an almost homogeneous mass of cellular tissue and starch. Roughly speaking, two fifths of its weight consists of water, and nearly one half of starch; sugar forms 6 per cent. of its weight; and the small residuum consists of oil, albuminous compounds, cellulose, and a little fibrous tissue and mineral matter. It is obviously a wholesome nutritious root; and the corms of several species are largely used for food in Syria, and form a regular article of commerce in the markets of Damascus, where they are sold at about $2\frac{1}{2}d.$ an imperial pint under the name of "Hŭrsineen."

The only structural features of the corm-mass I need refer to are traces of vascular tissue, running as an irregular column

from its base to its depressed apex; but this is to all intents dead and functionless in the new corm, and is merely the remnant of the connecting link between last year's foliage and last year's corm, and takes no part in the economy of the new life-course about to begin.

The surface of the flesh of the corm is delicately pitted all over; and in the centre of each of these depressions is a minute papillus, which I take to be an incipient or undeveloped bud. Many of these cover the corm-surface; and it is the development of one or more of them as bud-growths on which the future cycle of life depends. They are scattered indiscriminately over the corm-surface; and the position in which they are developed bears no relation to the old axis of growth. Usually one of them only enlarges near the top of the corm; and it is generally a little to the side of the vascular summit of the old corm. Many species produce these bud-growths all over the corm; and in two, *Crocus nudiflorus* and *C. lazicus*, their growth as stolons from various parts of the corm, independently of the old axis, is a constant feature. In two others, *C. Fleischeri* and *C. speciosus*, the buds are abundantly developed as bulbils or cormlets round the circumference of the old corm, and remain for the first year without producing foliage.

Concurrently with the commencement of the ascending growth is the production of roots from the bottom of the corm, and occasionally from other parts; but here, again, the old axis of growth is avoided. The roots are never produced directly from the basal scar, but at a greater or less distance round its circumference; and I have been unable to trace any connexion between them and the old vascular column.

The abundance of root-production in different species bears no relation to the size of the corm, nor does the size of the corm bear any ratio to the size or abundance of the flowers of individual species; but the abundance of roots is directly related to the floriferous character of each species. I would here notice that these delicate roots are the most permanent organs in the cycle of life, and remain unimpaired till the old corm to which they are attached has been finally absorbed and replaced by its successor.

The new corm during its first year of growth throws out no true roots; but during the later stages of its expansion a single tuber-like process is occasionally produced from the base of the

vascular column, and is again reabsorbed at the completion of growth, leaving a small basal scar at the point of articulation. The process of annual corm-replacement is exhibited in Plate XXXIV. The new growth is, as it were, planted into the substance of the old corm in a position which generally has no relation to its axis of growth; the new corm expands, absorbs the entire substance of its parent, and throws off a new set of tunics, which are added internally to the successive tunic-layers of many former generations. The tunics are homologous with the leaves; indeed, they are in part merely the expanded base of the leaves and sheathing-leaves, with a structure beautifully adapted for the protection of the annually expanding new corm.

In the early stages of the new growth the base of the foliage completely environs the incipient corm, and is articulated to its base within the mass of the old corm. As the new corm frees itself and expands, that part of the tunic which forms the bottom of the foliage disarticulates from the base of the corm in successive layers and slips upwards; this would leave the bottom of the corm exposed but for the existence of an organ I have termed the *basal tunic*. I look upon this as also homologous with the foliage; but its upward growth from the basal axis is so short that it adheres to the base of the corm, its short wiry rays clasping the base of the main tunic as it slips upwards; and these, like our own upper and nether garments, collectively maintain the continuity of the clothing.

Both the main tunic and the basal tunic present a great variety of adaptation. The vascular structure of the leaf is reproduced in the main tunic, which has a series of strong vertical costæ or fibres and intervening reticulations. A piece of net hung vertically will roughly represent the leaf-skeleton; and when drawn out laterally will as well represent a reticulated corm-tunic. This is in fact what really takes place, the expanding corm spreading out the vascular structure, which appears in a more condensed form in the leaf. The relation between the structure of the leaf and the corm-tunic is manifested by the fact that those species having little vascular tissue in the leaves have invariably a thin membranous tunic devoid of strong fibres.

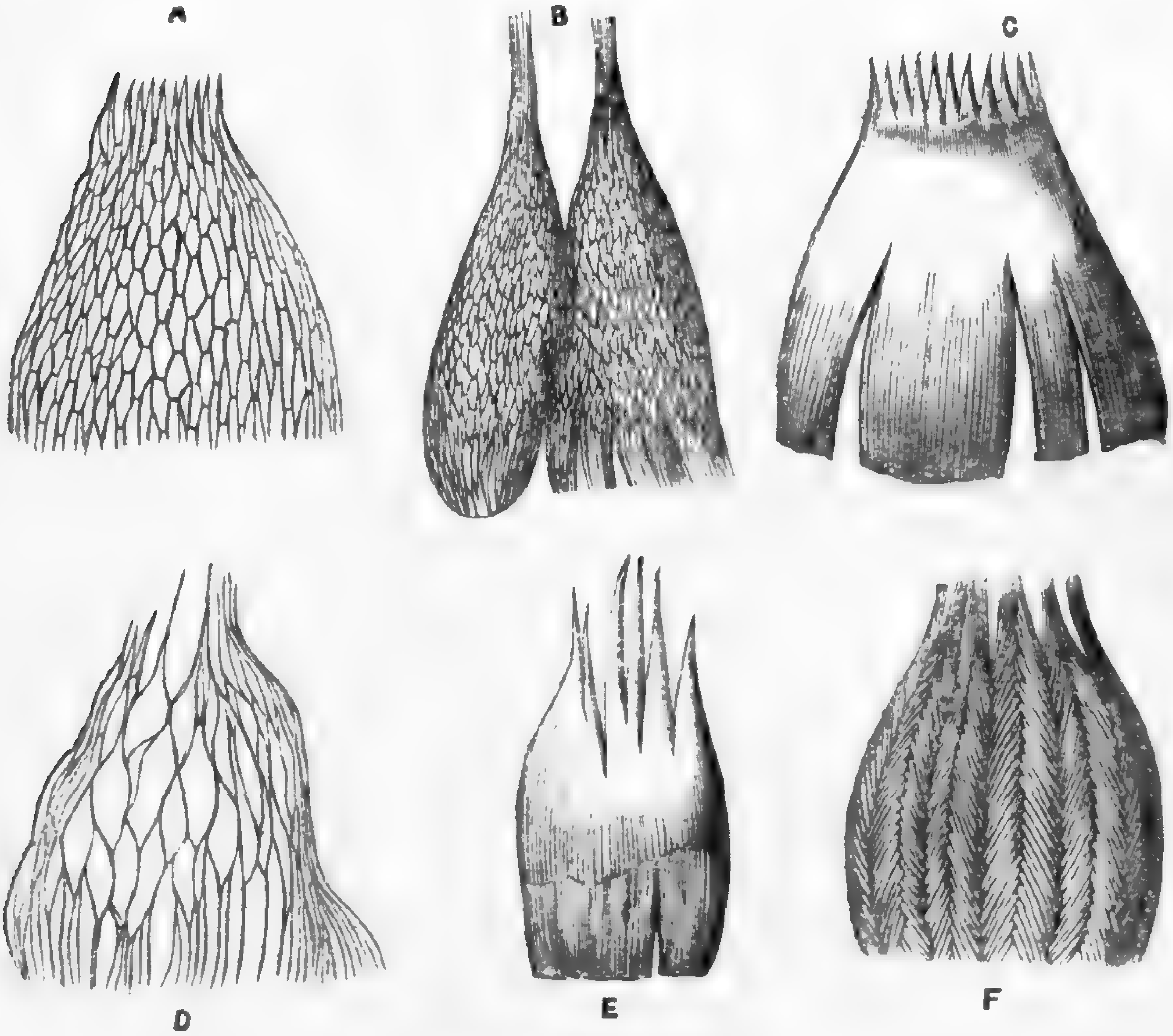
The limits of a single paper preclude my describing, with the detail that is necessary, the wonderful diversity of pattern and structure and the beautiful ornamentation found in the tunics of each species, exhibiting characters so well marked, that a mere

fragment is often sufficient for the determination of a species, and always constructed on a plan bearing on the economy of the plant-life.

I will merely refer to four or five of the more general types of structure of the tunics.

In addition to the main tunic, which is the expanded base of the foliage, there is a small tunic on the very apex of the corm which I have termed *the cap*: it merely differs from the main tunic in its size, and in its upward development into leaves being arrested. The basal tunic differs essentially from the upper tunics inasmuch as all the points of growth are united at the base, resulting in a single organ adhering to the bottom of the corm.

Fig. 1.



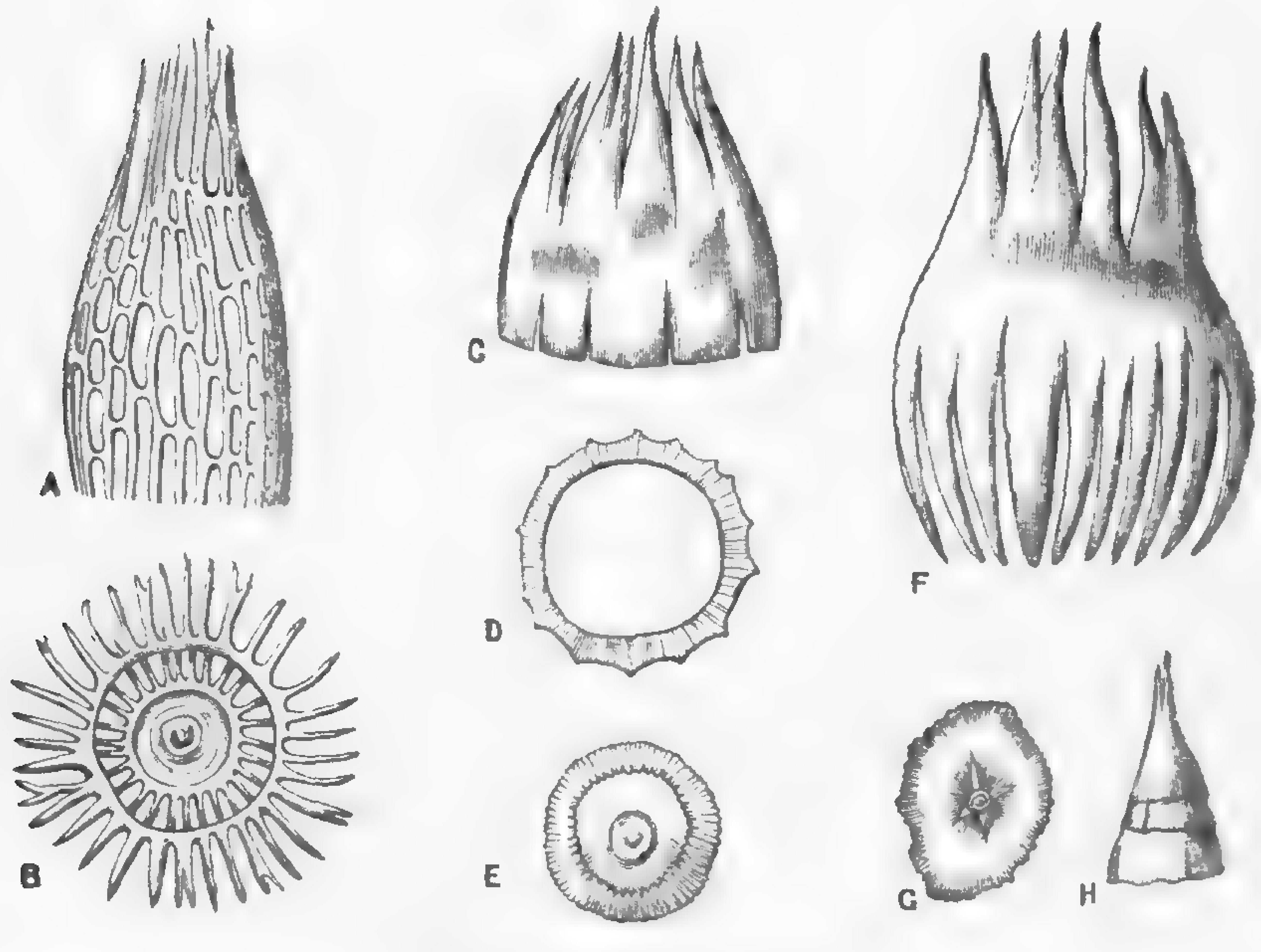
Corm-tunics of *Crocus*.
A. *C. Sieberi*. B. *C. Pallasii*. C. *C. serotinus*. D. *C. carpetanus*.
E. *C. versicolor*. F. *C. Fleischeri*.

The tunics of the great majority of the species consist of a fibrous skeleton on a membranous base, presenting a variety of pattern, and every gradation between parallel unbranched fibres and reticulated fibre, some of which are represented in figures

1 and 2. Some tunics are composed almost exclusively of membrane; others are strongly coriaceous, without much apparent fibre. The coriaceous and membranous tunics occasionally present a fibroid structure without having true fibre; and, as in the case of *Crocus aureus* and *C. serotinus*, the strong membranous tunic is split up into flat, fibre-like, parallel divisions. Perhaps the most remarkable tunic-structure is presented in two eastern species, *C. Fleischeri* and *C. parviflorus*, in which the fibres are distinctly platted into parallel vertical strands.

In the basal tunic we also find a great variety of pattern. It generally consists of a star-like structure of fibrous points, radiating from a central disk (fig. 2, C); and in all the coriaceous section, excepting *C. lævigatus*, the basal tunic consists of a series of imbricated annuli surrounded by short teeth (fig. 2, D). In *C. lævigatus*, in which the annuli are absent, the main tunic is split up at the base into a series of vandyke divisions (fig. 2, F), which in the first year clasp and protect the base of

Fig. 2.



Corm-tunics of *Crocus*.

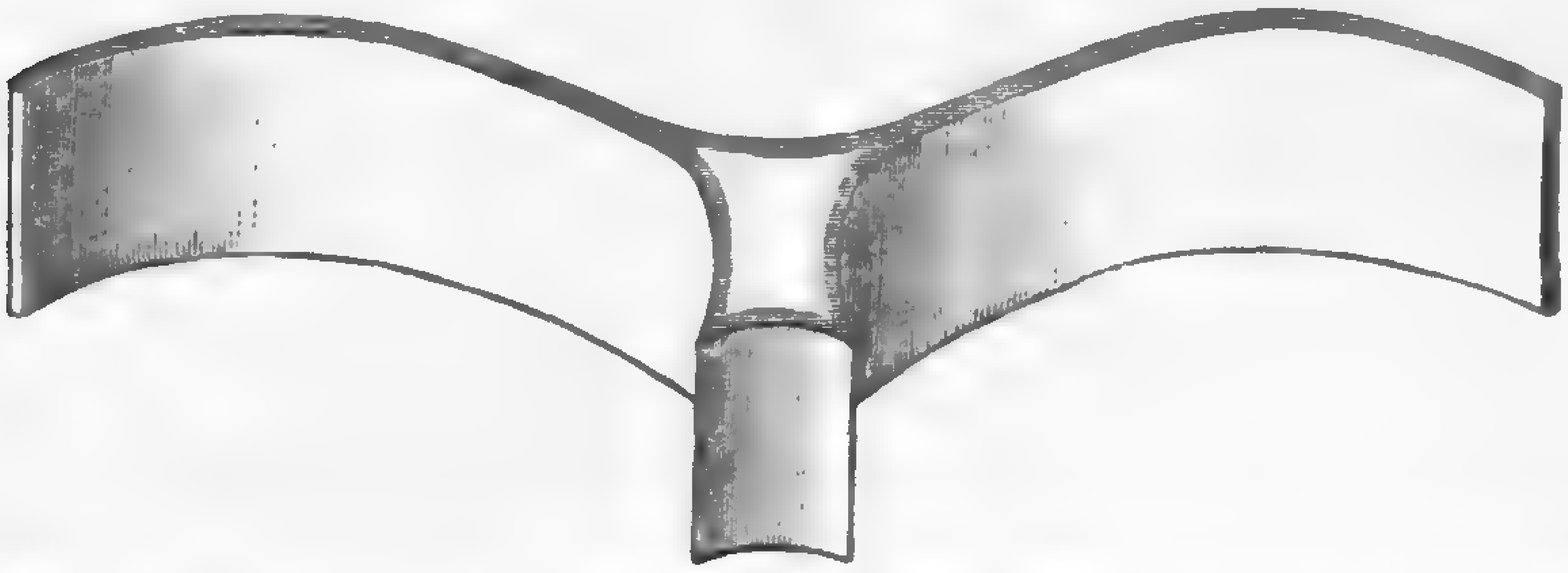
A & B. *C. cancellatus.* C, D, E. *C. Danfordiæ.* F, G, H. *C. lævigatus.*

the corm. All these diverse structures, which have little relation to each other as regards *pattern*, are distinctly related to one common purpose—the reproduction of the corm and its annual

expansion within the tunics. The membranous tunics rupture by the corm-expansion and split up from the base; but the superimposed layers maintain the continuity of the covering. The function of the reticulated structure is also obvious, allowing of lateral expansion, which is also provided for in the stranded tunic of *Crocus Fleischeri*; but this widening out *laterally* involves the vertical drawing up of the tunic from the base of the corm, and, but for the presence of the basal tunic, this would be left bare. The claw-like rays of the usual pattern spring strongly upwards and inwards, and tightly grasp the base of the main tunic as it slips upwards. The annuli of the annulate species, with the rows of little teeth on their upper margins, slip over each other and cling with the teeth to each other and to the bottom of the main tunic; and in *C. lævigatus*, where the annuli of the basal tunic are absent, there is an adaptation of the main tunic in its vandyke divisions, which strongly bend inwards and downwards to clasp the bottom of the corm.

Leaf-structure.—Of the two distinct sets of leaves, the outer series or sheathing-leaves are much shorter and broader than the proper leaves, and closely envelop the base of the plant. They vary from three to six in number, the inner being invariably longer than the outer; and they graduate both in height and in structure in an inward direction towards the proper leaves. The sheathing-leaves generally fall short of, but in some species exceed and hide the proper spathe, a character which is sufficiently constant for specific determination.

Fig. 3.



Leaf-section of *Crocus iridiflorus*, enlarged about 10 times nat. size.

The next organs we approach in an inward and upward direction are the proper leaves, familiarly known as "the grass" of the Crocus: these present a great diversity of structure. The more common type is represented in section in fig. 5A, *C. vernus*.

The blade is generally about one eighth of an inch wide, the keel usually about one third of the width of the blade. The blade is always more or less revolute, its margins approaching the margins of the keel, and the intervening spaces at the back of the blade are the lateral channels. These differ much in different species, and vary from being entirely open, as in the case of *C. iridiflorus*, to being closed by the margin of the blade meeting the margin of the keel. In the majority of species the lateral channels have a plain surface; and in some others they contain one, two, or three more or less prominent ribs, the presence or absence of which is a character for specific distinction.

The proper leaves are generally glabrous; but in certain species, *e. g.* those allied to *C. sativus* and to *C. aureus*, the margins of the keel and of the blade are ciliated. Of the several departures of the leaf-structure from the general type, the two vernal Spanish species *C. carpetanus* and *C. nevadensis* are the most remarkable. In *C. carpetanus* the distinction between blade and keel is lost; the leaf is semicylindrical, and the back furrowed with about sixteen alternating ribs and channels in lieu of a distinct keel and lateral channels. The South-Spanish *C. nevadensis* presents in its leaves a character intermediate between those of *C. carpetanus* and of the ordinary type, the back being ribbed and furrowed as in *C. carpetanus*, but also divided by slight lateral channels.

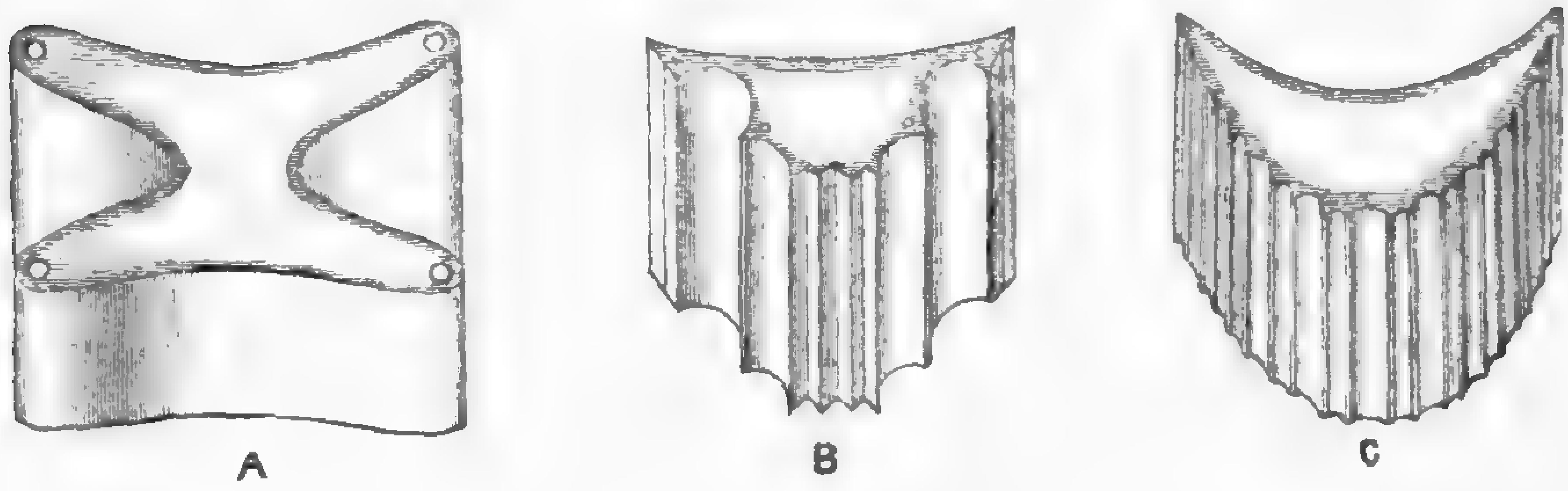
In *C. zonatus*, *C. vallicola*, and *C. Scharojani*, three species from Eastern Asia Minor, we have another aberrant type of leaf-structure. The keel being developed to the width, or nearly to the width, of the blade, and the white central band of the blade being almost lost, the back and front of the leaf look nearly alike. I shall have occasion further to notice these special leaf-structures when I refer to the presence of special secondary characters in relation to geographical distribution.

The leaves of the great majority of the species appear with the flowers; but in *ten* autumnal species (*C. iridiflorus*, *C. vallicola*, *C. Scharojani*, *C. zonatus*, *C. karduchorum*, *C. nudiflorus*, *C. medius*, *C. peloponnesiacus*, *C. speciosus*, and *C. pulchellus*) the leaves remain dormant within the sheathing-leaves till the ensuing spring. In the other fifty-nine species the leaves appear at the flowering-time; in some they are well developed before the flowers appear, and in other species are only just visible beyond the sheathing-leaves. The leaves of every species continue to lengthen up to

the completion of the plant-growth, when they vary from 8 or 9 inches to $\frac{1}{2}$ a yard in length, and from $\frac{1}{20}$ to $\frac{1}{2}$ an inch in breadth; they die away contemporaneously with the maturity of the seed, in June or July, except in two species, *C. Scharojani* and *C. karduchorum*, the leaves of which often last on till the ensuing autumnal flowering-time, the leaves of two years thus existing contemporaneously, the old set appearing outside the sheathing-leaves, and the new set hidden within them.

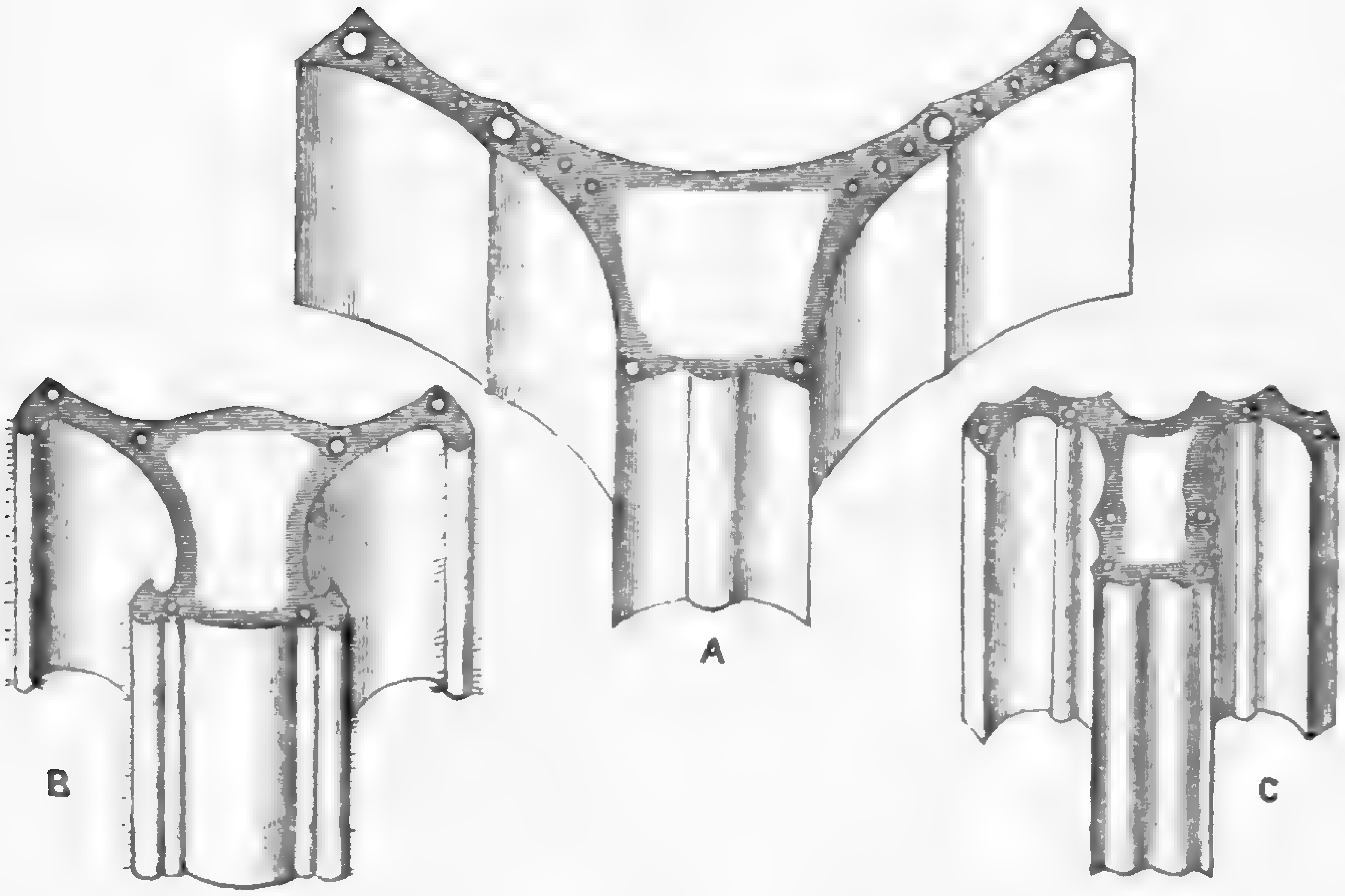
The number of the leaves varies considerably in different

Fig. 4.



Leaf-sections, enlarged about 10 times nat. size.
A. *Crocus vallicola.* B. *C. nevadensis.* C. *C. carpetanus.*

Fig. 5.



Leaf-sections, enlarged about 10 times nat. size.
A. *Crocus vernus.* B. *C. sativus.* C. *C. nudiflorus.*

species. In *C. medius* rarely more than two, or at most three or four, are produced; in some species there are as many as ten or twelve to a corm; roughly speaking, the number of the proper leaves is small in proportion to their width.

The Scape.—Of the ascending axis from the corm-summit to the base of the ovary I have little to observe. It is either tetraquetrous or triquetrous, varying from $\frac{1}{4}$ inch to 2 inches high at the flowering-time, but lengthens rapidly as the capsule matures, and is brought above ground 5 or 6 inches above the corm-summit. As a rule, the shorter the scape at the flowering-time, the greater is its height at the maturity of the capsule. In some species, e. g. *C. nudiflorus*, but one scape and flower is produced within each set of sheathing-leaves; in others there are two or more scapes.

Spathes (Plate XXXV.).—The other foliaceous organs are the spathes, of which there are two distinct series—those springing from the base of the scapes, and those springing from the base of the ovary. The former are not always present; and the presence or absence of the basal spathe suggested to Herbert the classification of the genus into the main groups INVOLUCRATI and NUDIFLORI. Of the Nudiflori, the great majority are vernal; and most of the Involucrati are autumn-flowering species. The basal spathe is a membranous tube springing from the base of and enclosing the scape, and reaching just above the ovary. A basal spathe may include several scapes; but there is often a separate basal spathe to each scape.

The proper spathe, springing from the base of the ovary, consists of one or two membranous, or slightly foliaceous organs, one of which is tubular, and the other, when present, generally ligulate. When one only is present, it is invariably tubular. The presence of one or of two proper spathes is an almost constant character, valuable in the determination of species. The proper spathe, with a few exceptions, exceeds the sheathing-leaves, environing the tube to within an inch or an inch and a half of the throat.

The tube is invariably cylindrical, varying in the different species from $2\frac{1}{2}$ to 6 inches in length, and generally partaking, in its upper exposed portion, of the colouring of the flower. The awn-like process from the summit of the capsule is merely the remnant of the base of the tube intertwined with the remnant of the proper spathe.

The Perianth.—The throat is of special interest in relation to specific character, as the presence or absence of the beard (a small bunch of transparent hairs at the base of the filament) is a good distinctive specific character, so invariably constant that Haworth employed it for grouping the genus into two distinct sections, which he termed *Piligeri* and *Depilati* ; but whilst it is of great use for individual specific distinction, it is of no help for natural grouping.

The throat internally is almost always more or less orange; and in *albinos*, where the general flower-colouring is blotted out, the orange colour of the throat is still retained; even in the *albinos* of one or two orange species the orange of the throat is separately constant. The orange colour of the throat, though often showing through to the outside, is on the inner surface only, and it is nicely limited to where the fallen pollen-grains accumulate. These have a strong power of staining; and I venture to suggest whether this golden zone of the throat may not be an inherited character from the mere mechanical tincture of the fallen orange pollen-grains, just as in many animals the bleaching and zonal colouring of hair and feathers round the orifices of the body suggest to the eye a relation to the functions of which they are the channels.

The perianth-segments vary from $\frac{1}{2}$ inch to $2\frac{1}{2}$ inches in length; the segments of the inner whorl are invariably somewhat shorter than those of the outer. In *Crocus iridiflorus* the difference is so much more striking than in any other species, that it suggested to Schur its generic separation as *Crociris*.

There appear to be two distinct sets of colour-cells in the segments, the colour of the inner surface never exactly corresponding with the outer; and by a little dextrous manipulation, the cells of the segments can be peeled off as three distinct layers, the central layer being almost colourless.

Excepting the self-coloured species, the colouring of the outer surface of the outer segments is notably different to that of the inner segments as well as to that of their inner surface. In the species with distinct feathered markings the feathering is limited to the outer segments, excepting in *Crocus versicolor*, in which the external feathering is nearly equally applied to all six segments. In all other species the inner whorl is either differently feathered, or unfeathered with just an indication at the base of a few lines of incipient feathering. Although any well-

pronounced featherings are external, there are a few species (*e. g. C. zonatus*, *C. pulchellus*, and *C. vallicola*) in which the purple veining is on the inner surface.

In the blue and white species the featherings are purple, and in the orange species rich brown; but in each case the colour-cells of the external featherings are purple, the brown colour of the featherings of the orange species being due to the overlay of purple on the orange ground.

In the pale forms and albinos of the orange species, the featherings appear as purple instead of brown.

The presence of feathered markings is not a stable specific character, as the majority of the species vary with self-coloured flowers and with flowers externally striped and feathered. Indeed, colour is of the least importance for specific distinction. Nearly all the Cyanic species vary in every shade of colour and with white flowers; and even the Xanthic species occasionally vary to white, and even blue, but this is very exceptional; and the Xanthic species are more constant in their colouring than the Cyanic. I know of no case in which a Cyanic species varies with orange flowers, though Herbert was bold enough to place the orange *C. susianus* as a variety of the lilac *C. reticulatus*, and *C. chrysanthus* and *C. biflorus* as varieties of one species; but this view cannot now be accepted.

There are two or three special points in colour-variation which must be noticed. A few species (e. g. *C. vernus*, *C. asturicus*, *C. versicolor*, and *C. aërius*) are essentially various in their colouring; and in these it is difficult to find two flowers precisely similar even in the same habitat. There are other species that are perfectly constant; and again those that are similarly coloured in the same habitat, but which present geographical variations—e. g. *C. cancellatus* at its western limit, in the Ionian Islands, has white flowers; eastward, in Greece, the segments put on a lilac tint; still further to the east, in Asia Minor, the colour deepens; and in Syria and Cilicia *C. cancellatus* occurs only of a clear purple colour. This tendency to change, eastward, from white to purple does not stand alone, and is also noticeable in *C. biflorus*. The Italian form is generally white, varying occasionally with lilac; but in Georgia, in the variety of *biflorus* known as *C. Adami*, the limb is invariably lilac or purple.

There are also many cases of mimetic variation—two distinct species putting on, in the same district, some identical form of marking or colouring. I shall have further to refer to this in

treating of the geographical distribution of the genus and of the presence of special characters related to geographical association.

The Filament, which springs from the base of the three outer segments, is generally white or yellow; it often partakes of the colour of the throat; and in several deep-purple species the filament is purplish. In a few species, notably in those with white anthers, the filament is essentially orange; and in *C. cyprius* it is scarlet. The filament is generally a little papillose; and in two or three species, e. g. *C. pulchellus* and *C. Tournefortii*, is densely covered with hairs.

The filament is generally about half the length of the anther; in *C. minimus* it is as long, and in *C. Boissieri* much longer than, the anther. The relative length of the filament and anther is constant within each species, and is of use for specific diagnosis.

The Anther.—There are few special specific characters in the anthers that need be referred to, except that in seven or eight species the anthers are white, in one species (*C. Crewei*) dark chocolate, and in all the remaining species orange. The colour of the anthers, unlike the variable colour of the stigmata, is constant within each species, and, as far as my observations go, never varies excepting in the occasional occurrence of dark-chocolate tissue near the base. The only other special specific character I have met with is in the suddenly divergent anther of *C. aureus*, which distinguishes that species from any other.

Pollen.—The pollen-grains have also their special specific characters, varying much in size, from $\frac{1}{550}$ to $\frac{1}{200}$ of an inch in diameter in different species. Within each species the size is constant; they are regular spheres, excepting only in *C. sativus* and the allied species, in which they are variable in size and also of irregular form. The grains of the great majority of species are orange, those of the white-anthered species pale cream-colour. In about half the species they are covered with minute papillæ, and in the remainder are glabrous. In the pollen-grains of *C. aureus* and its allies Mohl, followed by Edgeworth, described the presence of a spiral coil or double loop, which, Mr. Carruthers has ascertained, is due to the thinning or channelling of the outer coat of the grain. I have also detected it in *C. carpetanus*, *C. ancyrensis*, and one or two other species.

Stigma.—The stigmata present a great variety of types, so diverse in their character that I am unable to adopt the threefold classification, based on the stigmata, proposed by Mr. Baker. It is beyond the scope of this paper to particularize the various

Fig. 6.

Stigmata of Croci, enlarged four times.

1. *C. sativus.* 2. *C. iridiflorus.* 3. *C. medius.* 4. *C. lævigatus.* 5. *C. montenegrinus.* 6. *C. nevadensis.* 7. *C. aureus.* 8. *C. carpetanus.* 9. *C. Olivieri.* 10. *C. biflorus.* 11. *C. vernus.* 12. *C. caspius.* 13. *C. parviflorus.*

patterns of stigmata, nearly all of which are special to each species. In *Crocus sativus* and its allies the stigmata are bright scarlet and entire. In the great majority of species they are orange, more or less divided. In *C. vitellinus* and several allied species they are developed as a bunch of capillary divisions; in *C. aureus* as a condensed mass of nearly sessile stigmata, forming the termination of the style.

The most remarkable departure from the ordinary type, as regards colour, is in *C. iridiflorus*, in which the finely divided stigmata are rich purple. In two vernal Spanish species, *C. carpetanus* and *C. nevadensis*, the almost sessile stigmata are of a pale semitransparent whitish grey, tending to lavender. The colour of the stigmata is not so constant as that of the anthers. In *C. vernus*, and several other species which have orange stigmata, they vary to cream-colour, and in *C. aureus*, the stigmata of which are normally pale buff, to rich orange. The stigmata of *C. chrysanthus* are very variable both in size and colour, ranging from pale buff to bright orange-scarlet.

The height of the stigmata is tolerably constant within each species; but in this respect individual species greatly differ, the stigmata much exceeding, equalling, or falling short of the summit of the anthers.

Whilst I view the character of the stigmata as of little use for natural grouping, it is invaluable for specific determination. In quite half of the species the stigmata are so special in their character, that they may be relied on alone for the determination of species.

Capsule.—The capsule or seed-pod presents few distinctive specific characters; and in both size and proportion, in the same species, is very variable. Perhaps the only exception is in the case of *C. gargaricus*, the capsules of which are almost as broad as high; but beyond this I do not know of any case in which they present good and stable distinctive characters.

The ovary of the autumnal species remains underground till the latter part of April, when the scape rapidly elongates with the growing capsule, bringing it to the surface. The capsules of the vernal species appear above ground at the same time as the autumnal.

The seed is matured in June and July, the valves of the capsules being suddenly reflexed as the seed ripens. The seeds, just at the time of maturity, present many well-marked specific cha-

racters; but they are for the most part lost as the raphe, chalaza, and caruncle wither, and the dead-ripe seed parts with its distinctive colouring.

The two most general forms are a buff glabrous seed and a papillose red seed. In *Crocus vitellinus* and the allied species the seed is oblong in form and bright crimson in colour, with a glabrous shining surface. In *C. sativus* and its allies the seed is nearly spherical and of a madder-red colour. In *C. aureus* the seed is crimson and covered with minute hairs. In *C. gargaricus* the nearly spherical seed is bright orange. The buff seeds ripen to fawn-colour; and the red seeds pass through several changes of colour, commencing with bright rose, then red, and are, lastly, at maturity of a rich reddish-chocolate colour.

The ripe seed, which is dispersed at about midsummer, invariably remains dormant till the ensuing time of growth, of the autumnal species, in November, the vegetation of the vernal species being delayed till the spring.

Contemporaneously with the maturity of the seed, the foliage attached to the new corm and the roots attached to the remnant of the previous year's old corm die away, and the life-cycle is completed with the new corm in the condition of rest, from which the life-history of the plant was commenced.

Classification and Sequence.—In attempting a natural grouping of the genus and sequence of the species, a difficulty at once presents itself in the large number of well-marked characters possessed by individual species, which, as it were, interlace and overlap in other members of the genus. Community of character in one organ thus brings together a different set of species to those which would be associated by the common characters of another organ. For instance, if we take the structure of the corm-tunic as a basis for classification, it would group together species that would be widely separated by the character of the stigmata; again, the stigmatic characters bring together in close proximity species which have obviously little natural affinity. This difficulty, which presents itself in many genera, seems especially prominent in the genus *Crocus*; and when I come to deal with this subject in a tabular form in my monograph, I shall be able to show that the concurrent grouping of several common characters is almost entirely absent, excepting very small and isolated sections; and it will be seen that no one method of classification will enable the species to be arranged in strictly natural sequence,

and without making gaps which some other method would more easily bridge over. Any arrangement of the species of the genus must therefore be based on a joint view of all the characters.

The first attempt at classification was by Haworth, in 1809, who grouped the genus into two sections he termed Piligeri and Depilati, including respectively the species with bearded and unbearded throats.

Herbert, about the year 1846, adopted for his primary grouping the presence or absence of a basal spathe, subdividing his main sections by the character of the corm-tunics.

Baker, in 1873, classified the genus into three sections—Holostigma, Odontostigma, and Schizostigma—by the character and degree of subdivision of the stigmata, with subordinate groups for the spring- and autumn-flowering species and those with Cyanic and Xanthic flowers.

I prefer Dean Herbert's method to that of Mr. Baker, as community of character of the stigmata seems to associate the species unnaturally; and there is greater variety of type than can be properly represented by three groups only; and in several species, e. g. *Crocus longiflorus*, individual flowers vary with every variety of structure, from the entire to the finely divided stigmata.

The grouping of the species I have adopted is based on Herbert's classification, except that I place in a separate section as *Annulati* those species having an annulate corm-tunic; and I separate *Crocus Fleischeri* and *C. parviflorus* under a distinct section I have termed *Intertexti*.

Division I.—INVOLUCRATI.

Species with a basal spathe springing at the base of the scape from the summit of the corm.

Section 1. *Fibro-membranacei.* With a corm-tunic of membranous tissue interspersed with nearly parallel fibres.

Autumn-flowering.

1. iridiflorus.	6. nudiflorus.	10. Clusii.
2. vallicola.	6 *b.* granatensis.	11. ochroleucus.
3. Scharojani.	7. asturicus.	12. lazicus.
4. zonatus.	8. serotinus.	13. Cambessedesii.
5. karduchorum.	9. Salzmanni.	

Spring-flowering.

14. Imperati.
15. suaveolens.
16. versicolor.
17. Biliottii.
18. Malyi.
19. minimus.
(20. Boissieri ?)

Section 2. *Reticulati*. With a corm-tunic of distinctly reticulated fibres.

Spring-flowering.

21. corsicus.
22. etruscus.
23. montenegrinus.
24. banaticus.
25. Tommasinianus.
26. vernus.

Autumn-flowering.

27. medius.
28. longiflorus.
29. sativus, and subspecies allied to sativus.
30. hadriaticus.

Division II.—NUDIFLORI.

Species without a basal spathe.

Section 1. *Reticulati*. With a corm-tunic of distinctly reticulated fibres.

Autumn-flowering.

31. cancellatus.

Spring-flowering.

32. veluchensis.
33. Sieberi.
34. dalmaticus.
35. reticulatus.
36. susianus.
37. stellaris.
38. ancyrensis.
39. gargaricus.
40. Gaillardotii.
41. carpetanus.

Section 2. *Fibro-membranacei*.

Spring-flowering: lilac or white.

42. nevadensis.
43. hyemalis.
(44. hermoneus ?)
45. alatavicus.

Autumn-flowering: lilac or white.

46. caspius.
47. Tournefortii.
48. veneris.
49. lævigatus.
49 *b*. Boryi.

Spring-flowering: orange, except *candidus*, which is white.

50. vitellinus.
51. Balansæ.
52. Suterianus.
53. Olivieri.
54. candidus.
55. aureus.
56. Korolkowi.

Section 3. *Annulati.* Basal tunic of corm separating into annuli.

Spring-flowering.

57. cyprius.
58. aërius.
59. biflorus.
60. Crewei.
61. tauri.
62. chrysanthus.
63. Danfordiæ.

Autumn-flowering.

64. speciosus.
65. pulchellus.

Section 4. *Intertexti* (Spring-flowering). With a corm-tunic of stranded or plaited fibres.

66. Fleischeri.
67. parviflorus.

Geographical Distribution.—The known limits of the genus, which is confined to the Old World in the northern hemisphere, may be approximately stated to be between 9° W. and 87° E. longitude, and 55° N. and 31° N. latitude, the main eastern limit being 50° E. longitude and main northern limit 48° N. latitude—the occurrence of *C. alatavicus* in the Ala-Tau Mountains of Central Asia carrying the genus far north-east of the general area of occurrence. *C. Clusii,* in Portugal, is the most western species, *C. hyemalis,* in South Palestine, the most southern species at present known, and *C. Salzmanni* the most south-western species.

The area of distribution of the genus would roughly centre round the Mediterranean and Black-Sea coasts, though it does not form an essential feature of what is known as the Mediterranean flora, many of the species ascending to high ranges of altitude.

Looking at the prevalence of species and to general wide distribution, the district, including Greece, the Greek Archipelago, and Asia Minor, must be looked upon as the metropolis of the genus; for in this region it forms a more important feature in the flora than the outlying countries to which it extends.

As a means of indicating in a concise form the general range of the species, I propose to divide the region occupied by the genus into nine subdistricts, giving lists of the species occurring in each, and expressing by letters the extension of the species of each district into neighbouring districts.

The division into subdistricts may be to some extent arbitrary; but it has been as far as possible ruled by natural geographical boundaries or the ascertained range of the more prominent species. Where a species is named in the subdistrict lists without

a following letter, its occurrence is limited to that district; and where the name of a species is followed by a letter, the letter indicates another district to which it extends.

A. West-European district, including Portugal and Spain, the Balearic Islands, and France, excepting the Alps:—

C. nudiflorus.	C. Clusii.	C. carpetanus.
C. granatensis.	C. Cambessedesii.	C. nevadensis. B.
C. asturicus.	C. vernus. C, D, E (G?).	C. Salzmanni. B.
C. serotinus.		

B. North-African district, including Morocco and Algeria:—

C. Salzmanni. A.	C. nevadensis. A.

C. Swiss and French Alps, Maritime Alps, and Tyrol:—

*C. versicolor. D.	C. vernus. A, D, E (G?)	*C. medius. D.

D. Italy, as far east as Venice; Sicily, Malta, Sardinia, and Corsica:—

C. biflorus. E, F, G.	C. minimus.	* C. medius. D.
C. Imperati.	C. corsicus.	C. longiflorus. (E?)
C. suaveolens.	C. etruscus.	C. sativus. E, F, G.
*C. versicolor. C.	C. vernus. A, C, E (G?)	

E. East-European district, east of the longitude of Venice and as far east as the longitude of Odessa, including Dalmatia, the Danubian Principalities, the Carpathians, Greece, the Ionian Islands, the Greek Archipelago and Crete, and Turkey in Europe:—

C. iridiflorus.	C. cancellatus. F, G. H.	C. lævigatus.
C. Malyi.	C. veluchensis.	C. Olivieri. (F?)
C. montenegrinus.	C. Sieberi. (F?)	C. aureus. F.
C. banaticus.	C. dalmaticus.	C. biflorus. D, F, G.
C. Tommasinianus.	C. reticulatus. F, G.	C. Crewei.
C. vernus. A, C, D (G?)	C. Tournefortii.	C. chrysanthus. F.
C. (longiflorus?). D.	C. veneris. F.	C. speciosus. F, G.
C. sativus. D, F, G.	C. Boryi.	C. pulchellus. F.
C. hadriaticus.		

F. Asia Minor, Cyprus, Kurdistan:—

C. vallicola. G.	C. reticulatus. E, G.	C. cyprius.
C. Scharojani. G.	C. ancyrensis.	C. aërius.
C. zonatus. (H?)	C. gargaricus.	C. biflorus. D, E, G.
C. karduchorum.	C. veneris. E.	C. tauri.
C. lazicus.	(C. vitellinus?) H.	C. chrysanthus. E.
C. Biliottii.	C. Balansæ.	C. Danfordiæ.
C. Boissieri.	C. Suterianus.	C. speciosus. E, G.
C. sativus. D, E, G.	(C. Olivieri?) E.	C. pulchellus. E.
C. cancellatus. E, G, H.	C. candidus.	C Fleischeri.
(C. Sieberi?) E.	C. aureus. E.	C. parviflorus.

* *C. versicolor* and *C. medius* occupy a small district of the Maritime Alps bordering on France and Italy and within each boundary, and are therefore included in both lists, C and D.

G. The Circassian and Caspian district, including Southern Russia east of the longitude of Odessa, the Crimea, Georgia, the district bordering the west coast of the Caspian Sea, and North Persia:—

C. vallicola. F.	C. cancellatus. E, F, H.	C. caspius.
C. Scharojani. F.	C. susianus.	C. biflorus. D, E, F.
(C. vernus?) A, C, D, E.	C. reticulatus. E, F.	C. speciosus. E, F.
C. sativus. D, E, F.		

H. Syria and Palestine:—

(C. zonatus?) F.	C. Gaillardotii.	C. hermoneus.
C. ochroleucus.	C. hyemalis.	C. vitellinus. (F?)
C. cancellatus. E, F, G.		

I. Central Asia and west of the Caspian, Ala-Tau Mountains, and Samarkand:—

C. altavicus.	C. Korolkowi.

In the centre of the area of distribution of a genus it is only to be expected that there will occur a greater intermingling of species than on its confines; but in the case of the Croci the isolation of the species at the extreme eastern and western end of the Crocus-area is remarkable, the species being notably less transgressive into the centre of the area of distribution than the intermingling of species over wider areas within the centre of distribution. I can offer no sufficient explanation of this fact: the West-European species (district A) are essentially endemic, and so are the Syrian species (district H). The two species of Central Asia are naturally isolated, and do not occur in any of the other districts. Of the ten West-European species all are endemic, except *Crocus vernus*, which occurs very sparingly in the Pyrenees, and is not at home there as in the Alps, and *C. nevadensis* and *C. Salzmanni*, which are also found in North Africa. The affinity of the two North-African species is obviously Spanish; and they might perhaps be better associated with the West-European district. Of the six or seven Syrian and Palestine species, with the exception of *C. cancellatus*, they are all endemic. It is doubtful whether *C. zonatus* really crosses the Cilician boundary and occurs in Syria; *C. vitellinus* was, I believe, found by Mrs. Danford in the anti-Taurus; but both these are merely borderers, just passing the geographical boundary. And it is also doubtful whether *C. sativus* really occurs in Syria; the only record I know of is that of a single bulb from the neighbourhood of Damascus, mentioned by Herbert as "a smooth-leaved variety

of *C. sativus*," which he named *C. intromissus*, which was probably *C. Gaillardotii*, a species peculiar to Syria then undescribed. Nearly the whole of the species occupy continuous areas, and, with the exception of *C. vernus*, there is no case of repeated occurrence in isolated districts separated by wide breaks. *C. vernus* has a range of about 27° of longitude, from the Carpathians to the Pyrenees; and the continuity of its range is somewhat broken in Central France.

C. biflorus has a wider range of longitude than any other species, extending for 38° from Italy into Georgia; and the next in order of wide distribution is *C. sativus* in its various forms, extending through 30° of longitude from Italy to Kurdistan; and its distribution is essentially Oriental. The same may be said of the annulate species, which have only one representative, *C. biflorus*, as far west as Italy.

Of the division *Involucrati*, there are about thirteen vernal and seventeen autumnal species; and of the *Nudiflori*, thirty are vernal and eight autumnal. The orange species all occur east of the Adriatic; of the thirty species of *Involucrati*, about half occur to the east, and half to the west of the Adriatic; and the *Nudiflori*, with two or three exceptions, are all limited to the region east of the Adriatic.

The genus is remarkable for the wide ranging in altitude of the majority of species, those that are essentially alpine or lowland being comparatively few in number; and I believe there is no single species of the genus that is not perfectly hardy, and capable of enduring any of the extremes of frost and heat of our climate.

Geographical Distribution in relation to Natural Affinities.—I must conclude this paper with a brief notice of a few points I have observed on geographical distribution in relation to affinity and to special secondary characters; some of these are of exceptional interest.

The grouping geographically of allied species is not general; and the only two notable exceptions present themselves in Western Europe and in Italy.

In the Peninsula and the neighbouring part of France there are six or seven autumnal species, viz. *C. nudiflorus*, *C. granatensis*, *C. asturicus*, *C. serotinus*, *C. Salzmanni*, and *C. Clusii*, all closely allied and forming a compact group; and, with the exception of *C. Salzmanni*, which also occurs on the Barbary coast, they are all limited to Western Europe, where there are no

other autumnal species. Two out of three vernal species, *C. carpetanus* and *C. nevadensis*, are essentially endemic and closely allied, especially in their singular leaf-structure; so that, with the exception of *C. vernus*, which is sparingly transgressive from the Alps, the whole of the West-European species are not only endemic, but the species of the vernal and of the autumnal respectively range themselves into compact groups. In Italy and the Italian islands the endemic vernal species form also a natural group; but they are associated with *C. biflorus* and *C. vernus* of wider range. Beyond these two cases, I know of no example in which either the bulk of the vernal or the bulk of the autumnal species predominate as natural groups; as a rule, the several types are intermixed.

We find, however, many striking cases of the geographical isolation of individual species, the islands of the Mediterranean affording the most conspicuous examples. The remarkable *C. Cambessedesii* is limited to the Balearic Islands. Corsica and Sardinia and the neighbouring islets have two species, *C. corsicus* and *C. minimus*, which do not occur elsewhere. *C. Crewei*, with its singular black anthers, is limited to the little island of Syra; *C. cyprius*, the only species with a scarlet filament, is confined to Cyprus; and *C. veneris* to Cyprus and Crete.

Of insular varieties of species found on the mainland there are several striking examples: *C. hadriaticus*, which in Albania is either pure white or white with a purple throat, appears in the neighbouring island of Santa Maura with a golden-yellow throat; *C. vernus* is represented on the Sicilian mountains by the diminutive *C. siculus* and *C. Sieberi*, which is self-coloured lilac on the mountains of Greece, appears in Crete, Andros, and some other neighbouring islands with variegated purple and white flowers.

Of the passage in colour from white to blue, in one or two species in their ranging from west to east, I have already referred to; and there are other somewhat similar cases of colour-variation, running, as it were, parallel through several species within the same district. In illustration of this, I would refer to the general absence of striping and feathering of species occurring in Dalmatia, which occur elsewhere with feathered flowers. There are also even more marked cases than this of mimetic colouring, and of different species associated in the same habitat putting on some identical special form of colouring. I would especially name the exact identity in colour and markings of the Santa-Maura

varieties of *C. cancellatus* and *C. hadriaticus,* species which are not nearly allied, and the type-colourings of which differ from the Santa-Maura forms. Another remarkable case is that of the form of *C. cancellatus,* found on the Bithynian Olympus in association with *C. aërius,* where it puts on the exact colouring of its companion; moreover, there is a large series of variations in the markings of *C. cancellatus* which are exactly mimetic of the variations in the colour of *C. aërius* with which it is associated.

I do not think that these are cases of hybridization; for, as far as my observations go, I have been unable to detect a single wild hybrid; nor do I know of any authenticated case of the production of garden-hybrids. It has been suggested that the sterile *C. stellaris,* an old garden-plant the origin of which is unknown, may be a hybrid between *C. aureus* and *C. susianus*; but mere sterility is not sufficient evidence, as it is within my own experience that many wild species tend to sterility after only two or three years cultivation.

Of Special Leaf-characters which seem to have to do with Geographical Association.—In addition to the case of the two vernal Spanish species just referred to, I would notice the remarkable identity of special leaf-structure, in which the keel is developed to nearly the width of the blade, in *C. zonatus, C. vallicola,* and *C. Scharojani,* three species from Eastern Asia Minor, a character found in no other species.

There is also a similar case in relation to special corm-tunic structure. *C. Fleischeri* and *C. parviflorus* both occur in the Taurus; they have few structural characters in common; and it is certainly remarkable that the singular stranded tunic found in no other species should be common to them both.

A case of geographical variation in the anther, common to two species, is presented in *C. biflorus* and *C. chrysanthus*: the anthers of both of these species are normally yellow; but in Western Bithynia they both vary with a dark spot at the base of the anther.

The only other point I have to refer to is the tendency to morphosis of nearly every part of a Crocus; the membranous spathes occasionally become foliaceous, and a proper leaf is sometimes seen springing out of and bedded in the spathe.

A stigmatic appendage to the anther is not unfrequent; in *C. montenegrinus* of Kerner, which he originally named *C. appendiculatus,* it seems to be constant. The segments also become

stigmatic. M. Chappellier, of Paris, has been cultivating a form of *C. sativus* in which the segments are developed as stigmata; and he hopes therefrom to increase the saffron production of the species. A somewhat similar case of morphosis occurs in a variety of *C. vernus* sent to me by Miss C. M. Owen, of Knockmullen, Gorey, Ireland, in which a bright-golden stigmatic band runs up the centre of each outer segment, and has the appearance of a stigma bedded into the mass of the flower.

It is difficult, within the limits of a single paper, to give more than a brief reference to many points which can only be properly treated of in detail. Both botanically and horticulturally the genus is of exceptional interest; and I shall hope ere long to deal with it in more fulness as a separate monograph.

Meantime I have added (in pages 372, 373) a Table containing a short analysis of the characters of all the species of the genus *Crocus*.

DESCRIPTION OF THE PLATES.

Plate XXXIV.

Corm-reproduction in Crocus. About one and a half times the actual size.

Fig. 1. Section of corm of *C. vernus*, at rest in July.
2. Ditto ditto with new corm partly developed.
3. Ditto ditto with new corm nearly matured.
4. Section of corm of *C. minimus*, with new corm nearly matured.
5. Corm of *C. nudiflorus*.
6. Section of corm of *C. speciosus*, with new corm nearly matured.

Plate XXXV.

Dissection of Spathes in Crocus. About half the natural size.

Tabular Analysis of the Specific Characters of the Genus Crocus.

Number.	Species. [The note of interrogation (?) is inserted where the character differs a little from that indicated at the heading of the column, or where there is some doubt or insufficient information.]	*Involucrati.* Basal spathe present.	*Nudiflori.* Basal spathe absent.	Diphyllous proper spathe.	Monophyllous proper spathe.	Tunic fibro-membranous.	Tunic reticulated.	Tunic annulate.	Tunic stranded.	Spring-flowering.	Autumn-flowering.	Leaves dormant at flowering-time.	Leaves appearing with flowers.	Leaves glabrous.	Leaves ciliated.	Flowers orange.	Flowers other than orange.	*Piligeri*, throat bearded.	*Depilati*, throat unbearded.	Throat orange or yellow.	Throat white or violet.	Anthers orange or yellow.	Anthers white.	Filament orange or yellow.	Filament white.	*Holostigma.* Stigma entire.	*Odontostigma.* Stigma slightly divided.	*Schizostigma.* Stigma much branched.	Seed buff.	Seed red.	East of longitude of Venice.	West of longitude of Venice.
1.	iridiflorus	*	...	...	*	?	...	...	...	...	*	*	...	*	...	...	*	...	*	...	*	*	...	...	*	...	...	*	...	*	*	...
2.	vallicola	*	...	...	*	*	...	...	...	...	*	*	...	*	...	...	*	*	...	...	*	...	*	...	*	...	*	...	*	...	*	...
3.	Scharojani	*	...	...	*	*	...	...	...	...	*	*	...	*	...	*	...	...	*	*	...	...	*	*	...	*	...	...	*	...	*	...
4.	zonatus	*	...	*	...	*	...	...	...	...	*	*	...	*	...	...	*	*	...	*	...	...	*	*	...	*	...	...	*	...	*	...
5.	karduchorum	*	...	...	*	*	...	...	...	...	*	*	...	*	...	...	*	...	*	...	*	...	*	...	?	...	...	*	...	...	*	...
6.	nudiflorus	*	...	...	*	*	...	...	...	...	*	*	...	*	...	...	*	...	*	...	*	*	...	...	*	...	...	*	*	...	...	*
6 *b.*	granatensis	*	...	...	*	*	...	...	...	...	*	*	...	?	...	...	*	...	?	...	*	*	...	...	?	...	...	*	?	...	...	*
7.	asturicus	*	...	...	*	*	...	...	...	...	*	...	*	*	...	...	*	*	...	...	*	*	...	...	?	...	...	*	*	...	...	*
8.	serotinus	*	...	...	*	*	...	...	...	...	*	...	*	*	...	...	*	*	...	...	*	*	...	...	*	...	*	...	?	...	...	*
9.	Salzmanni	*	...	...	*	*	...	...	...	...	*	...	*	*	...	...	*	*	...	*	...	*	...	*	...	...	*	...	?	...	...	*
10.	Clusii	*	...	...	*	...	*	...	...	...	*	...	*	*	...	...	*	*	...	...	*	*	...	?	...	...	...	*	...	*	...	*
11.	ochroleucus	*	...	...	?	*	...	...	...	...	*	...	*	*	...	...	*	*	...	*	...	...	*	*	...	...	*	...	...	...	*	...
12.	lazicus	*	...	...	*	*	...	...	...	...	*	...	*	*	...	*	...	...	?	*	...	*	...	*	...	*	...	...	...	?	*	...
13.	Cambessedesii	*	...	*	...	*	...	...	...	...	*	...	*	*	...	...	*	...	*	...	*	*	...	...	*	*	...	...	*	...	...	*
14.	Imperati	*	...	...	*	*	...	...	...	*	...	...	*	*	...	...	*	...	*	?	...	*	...	...	?	...	*	...	*	...	...	*
15.	suaveolens	*	...	...	*	*	...	...	...	*	...	...	*	*	...	...	*	...	*	*	...	*	...	*	...	*	...	...	*	...	...	*
16.	versicolor	*	...	...	*	*	...	...	...	*	...	...	*	*	...	...	*	...	*	...	*	*	...	...	*	*	...	...	...	*	...	*
17.	Biliottii	*	...	...	*	*	...	...	...	*	...	...	*	*	...	...	*	...	?	...	?	*	...	...	?	...	*	...	?	...	*	...
18.	Malyi	*	...	*	...	*	...	...	...	*	...	...	*	*	...	...	*	*	...	*	...	*	...	*	...	...	*	...	?	...	*	...
19.	minimus	*	...	*	...	*	...	...	...	*	...	...	*	*	...	...	*	...	*	...	*	*	...	...	*	*	...	...	...	*	...	*
20.	Boissieri	*	...	...	*	...	?	...	...	*	...	...	*	*	...	...	*	...	?	...	*	*	...	...	?	...	*	...	?	...	*	...
21.	corsicus	*	...	...	*	...	*	...	...	*	...	...	*	*	...	...	*	...	*	...	*	*	...	...	*	...	*	...	*	...	...	*
22.	etruscus	*	...	...	*	...	*	...	...	*	...	...	*	...	*	...	*	?	...	?	...	*	...	*	...	*	...	...	?	...	...	*
23.	montenegrinus	*	...	...	*	...	*	...	...	*	...	...	*	*	...	...	*	...	?	*	...	*	...	*	...	*	...	...	?	...	*	...
24.	banaticus	*	...	...	*	...	*	...	...	*	...	...	*	*	...	...	*	...	*	...	*	*	...	...	*	*	...	...	?	...	*	...
25.	Tommasinianus	*	...	...	*	...	*	...	...	*	...	...	*	*	...	...	*	...	*	...	*	*	...	...	*	*	...	...	...	*	*	...
26.	vernus	*	...	...	*	...	*	...	...	*	...	...	*	*	...	...	*	*	...	...	*	*	...	...	*	*	...	...	*	...	*	*
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
29.	sativus	*	...	*	...	...	*	...	...	...	*	...	*	...	*	...	*	*	...	...	*	*	...	...	*	*	...	...	...	...	*	*
30.	hadriaticus	*	...	*	...	...	*	...	...	...	*	...	*	...	*	...	*	*	...	...	?	*	...	...	*	*	...	...	...	?	*	...
31.	cancellatus	...	*	*	...	...	*	...	...	...	*	...	*	*	...	...	*	...	*	...	?	*	...	...	*	...	...	*	...	*	*	...
32.	veluchensis	...	*	*	...	...	*	...	...	*	...	...	*	*	...	...	*	*	...	...	*	*	...	...	*	*	...	...	?	...	*	...
33.	Sieberi	...	*	*	...	...	*	...	...	*	...	...	*	*	...	...	*	...	*	*	...	*	...	*	...	*	...	...	...	*	*	...
34.	dalmaticus	...	*	*	...	...	*	...	...	*	...	...	*	*	...	...	*	...	*	*	...	*	...	?	...	*	...	...	*	...	*	...
35.	reticulatus	...	*	*	...	...	*	...	...	*	...	...	*	*	...	...	*	...	*	...	?	*	...	*	...	*	...	...	*	...	*	...
36.	susianus	...	*	*	...	...	*	...	...	*	...	...	*	...	*	*	...	...	*	*	...	*	...	*	...	*	...	...	...	*	*	...
37.	stellaris	...	*	*	...	...	*	...	...	*	...	...	*	*	...	*	...	...	*	*	...	*	...	*	...	*	...	...	...	?	?	...
38.	ancyrensis	...	*	*	...	...	*	...	...	*	...	...	*	...	?	*	...	...	*	*	...	*	...	*	...	*	...	...	...	?	*	...
39.	gargaricus	...	*	...	*	...	*	...	...	*	...	...	*	*	...	*	...	...	*	*	...	?	...	*	...	*	...	...	?	...	*	...
40.	Gaillardotii	...	*	*	...	...	?	...	...	*	...	...	*	*	...	...	*	...	*	...	*	?	...	*	...	...	...	*	?	...	*	...
41.	carpetanus	...	*	*	...	...	*	...	...	*	...	...	*	...	*	...	*	...	*	...	*	*	...	...	*	*	...	...	...	?	...	*
42.	nevadensis	...	*	*	...	*	...	...	...	*	...	...	*	*	...	...	*	*	...	...	*	*	...	...	*	*	...	...	*	...	...	*
43.	hyemalis	...	*	*	...	*	...	...	...	*	...	...	*	*	...	...	*	...	*	*	...	*	...	*	...	...	...	*	?	...	*	...
44.	hermoneus	...	*	*	...	*	...	...	...	?	...	...	?	*	...	...	?	...	?	...	?	?	...	?	...	...	...	?	?	...	*	...
45.	alatavicus	...	*	*	...	*	...	...	...	*	...	...	*	...	*	...	*	...	*	*	...	*	...	*	...	*	...	...	?	...	*	...
46.	caspius	...	*	*	...	*	...	...	...	...	*	...	*	*	...	...	*	...	?	*	...	...	?	?	...	*	...	...	...	?	*	...
47.	Tournefortii	...	*	*	...	*	...	...	...	...	*	...	*	*	...	...	*	...	*	*	...	...	*	*	...	...	...	*	...	*	*	...
47 *b*	Boryi	...	*	*	...	*	...	...	...	...	*	...	*	*	...	...	*	...	*	*	...	...	*	?	...	...	...	*	...	*	*	...
48.	veneris	...	*	*	...	*	...	...	...	...	*	...	*	*	...	...	*	...	*	*	...	...	*	*	...	...	...	*	...	?	*	...
49.	lævigatus	...	*	*	...	?	...	...	...	...	*	...	*	*	...	...	*	...	*	*	...	...	*	*	...	...	...	*	...	?	*	...
50.	vitellinus	...	*	*	...	*	...	...	...	*	...	...	*	...	*	*	...	...	*	*	...	*	...	*	...	...	...	*	...	*	*	...
51.	Balansæ	...	*	*	...	*	...	...	...	*	...	...	*	...	*	*	...	...	*	*	...	*	...	*	...	...	...	*	...	*	*	...
52.	Suterianus	...	*	*	...	*	...	...	...	*	...	...	*	...	*	*	...	...	*	*	...	*	...	*	...	...	...	*	...	*	*	...
53.	Olivieri	...	*	*	...	*	...	...	...	*	...	...	*	...	*	*	...	...	*	*	...	*	...	*	...	...	...	*	...	?	*	...
54.	candidus	...	*	*	...	*	...	...	...	*	...	...	*	...	*	...	*	...	*	*	...	*	...	*	...	*	...	*	...	?	*	...
55.	aureus	...	*		...	*	...	...	...	*	...	...	*	...	*	*	...	...	*	*	...	*	...	*	...	*	...	...	...	*	*	...
56.	Korolkowi	...	*	*	...	...	*	...	...	*	...	...	*	*	...	*	...	...	*	*	...	*	...	*	...	...	...	...	...	?	*	...
57.	cyprius	...	*	...	*	...	...	*	...	*	...	...	*	*	...	...	*	...	?	...	*	*	...	*	...	...	*	...	?	...	*	...
58.	aërius	...	*	*	...	...	...	*	...	*	...	...	*	*	...	...	*	...	*	*	...	*	...	*	...	...	?	...	...	*	*	...
59.	biflorus	...	*	*	...	...	...	*	...	*	...	...	*	*	...	...	*	?	...	*	...	*	...	*	...	*	...	...	*	...	*	*
60.	Crewei	...	*	*	...	...	...	*	...	*	...	...	*	*	...	...	*	...	*	*	...	?	...	*	...	*	...	...	?	...	*	...
61.	tauri	...	*	*	...	...	...	*	...	*	...	...	*	*	...	...	*	...	*	*	...	*	...	?	...	*	...	...	?	...	*	...
62.	chrysanthus	...	*	*	...	...	...	*	...	*	...	...	*	...	*	*	...	...	*	*	...	*	...	*	...	*	...	...	...	*	*	...
63.	Danfordiæ	...	*	*	...	...	...	*	...	*	...	...	*	...	*	*	...	...	*	*	...	*	...	*	...	*	...	...	...	?	*	...
64.	speciosus	...	*	*	...	...	...	*	...	...	*	*	...	...	*	...	*	...	*	...	*	*	...	...	*	...	...	*	...	*	*	...
65.	pulchellus	...	*	*	...	...	...	*	...	...	*	*	...	*	...	...	*	...	*	*	...	...	*	*	...	...	...	*	...	*	*	...
66.	Fleischeri	...	*	*	...	...	...	...	*	*	...	...	*	*	...	...	*	...	*	*	...	*	...	?	...	...	...	*	...	*	*	...
67.	parviflorus	...	*	*	...	...	...	...	*	*	...	...	*	*	...	...	*	...	?	...	*	*	...	...	?	*	...	...	...	?	*	...
69		31	38	42	27	34	24	9	2	43	26	10	59	53	16	14	55	16	53	39	30	58	11	44	25	34	12	23	33	34	53	20

INDEX.

Abies (Arctic), 137; canadensis, 209; Hanburyana, 212; Hookeriana, 208, & synon., 211; Parryana, 212; Pattoniana, 208, 212; Pattonii, 208, & synon., 212; pectinata, 137; sp., 137; Williamsonii, 212.
Abola, 89.
Abutilon Avicennæ, 154; bidentatum, 154.
Acanthaceæ, 18, (Afghan) 182.
Acantholimon, 146, 147; calocephalum, 175; sp.?, 175.
Acer sp., 156.
Achæta, 91.
Achillea micrantha, 169; santolina, 169.
Achlæna, 56.
Achnatherum, 81.
Achneria, 94, 96.
Achnodon, 85.
Achnodonton, 85.
Achroostachys, 134.
Aciachne, 82.
Acicarpha, 42.
Acotyledones (Afghan), 194.
Acratherum, 59.
Acroelytrum, 120.
Acrophorus Hookeri, 291.
Acropselion, 97.
Acrostichum cervinum, 296; flagelliferum, 297; polyphyllum, 297; repandum, 297.
Acroxis, 82.
Actæa spicata, 146, 150.
Actinochloa, 104.
Action of Carb. of Ammonia on Roots of Plants, Chas. Darwin on, 239; — on Cell-sap, 269; — on Chlorophyll-bodies, 262.
Adhatoda vasica, 141.
Æcidia, exper. with, 335; Emilia, 335; flavidum, 335; Pavetta, 335; Tabernæmontana, 335.
Ægialina, 115.
Ægialitis, 115.
Ægilops, 131, 132.
Ægopogon, 62, 84, 105.
Æluropus, 117, 118, 122.
Æranthus filicornis, 338.
Ærua javanica, 185.
Afghanistan, flora of, 139; gen. observ. on, 139.
African Gossypium, 212.
Agaricus mitis, 194.
Agave, repair in, 8.
Agenium, 73.
Aggregation, a peculiar vital phenom. in veget., 262, 264, 266.
Agraulus, 88.
Agropyrum, 129, 130, 131; caninum, 130; hordeaceum, 131; junceum, 130; longearistatum, 130; orientale, 131; pectinatum, 130; repens, 130, 194; scabrum, 130; semicostatum, 130; villosum, 131.
Agrosteæ, 30, 40, 77; diagn. of tribe, 30.
Agrosticula, 86.
Agrostideæ, 28, 33.
Agrostis, 82, 86, 88, 89, 90, 91, 95; canina, 88; Munroana, 192; sesquivalvis, 91; spica-venti, 90; subaristata, 192; verticillata, 193.
Aira, 87, 93, 94, 95, 116; agrostidea, 94, 95; atropurpurea, 95; caryophyllea, 94; flexuosa, 95; involucrata, 95, 124; kœlerioides, 96; præcox, 94; pulchella, 95; sabulonum, 95; Tenorii, 94.
Airidium, 96.
Airochloa, 115.
Airopsis, 93, 96; globosa, 93.
Aitchison, J. E. T., Flora of Kuram Valley, Afghanistan, Part II., 139.
Aitchisonia, 144, 166; rosea, 144, 166.
Alcea rosea peregrina, 12.

Alectoridia, 68.
Alepyrum viride, 286.
Aleurone grains, solut. of, 242.
Algæ, act. carb. ammon. on, 284.
——, Himalayan, 230.
—— on Sloth's hair, 9, and spectral analysis of, 9.
——, repair in tissue of, 1.
Allelotheca, 120.
Allium, sp., 188, 245.
Alloteropsis, 42.
Alopecurus, 57.
Alstonia, 292; costulata, 291.
Althea palustris Cytini flore, 10, 12.
—— —— Wasser Ybisch, 11.
—— —— ulmifolia, 12.
Amarantaceæ (Afghan), 185.
Amblyachyrum, 67.
Ammannia baccifera, 162; pentandra, 162.
Ammochloa, 113.
Ammonia Carb., action of, on Roots of Plants, Chas. Darwin on, 239, 257.
Ammophila, 91.
Ampelodesmos, 112.
Amphibromus, 98.
Amphicarpum, 39.
Amphidonax, 93, 112; Heynei, 93; obtusiflora, 93; tenella, 93.
Amphigenes, 127.
Amphilophis, 72.
Amphipogon, 84; turbinatus, 84.
Amphochæta, 49.
Anacardiaceæ (Afghan), 156.
Anachyris, 36; paspalodes, 37.
Anaphalis contorta, 169; virgata, 169.
Anastrophus, 27, 36, 37, 38, 42.
Anatherum, 72.
Andropogon, 63, 66, 67, 71, 73, 142; albidus, 66; annulatus, 72; argenteus, 72; commutatus, 143, 191; fastigiatus, 72; hirtus, 72; Ischænum, 72; laguroides, 72; laniger, 143, 191; muricata, 72; nigritana, 72; paleaceum, 67; punctatus, 143; scandens, 72; schœnanthus, 72, 191; serratus, 72; tridentatus, 67; Vachellii, 72; virginicus, 72.
Andropogoneæ, 22, 28, 30, 32, 33, 63; diagn. tribe, 30.
Androsace sempervivoides, var. bracteata, 176; villosa, 176.
Androscepia, 74.
Anemagrostis, 90.
Anemone tetrasepala, 148.
Angelica Strattoniana, 147, 164.
Angræcum arcuatum, 338; bicaudatum, 338; capense, 338; chiloschistæ, 338; conchiferum, 338; Mystacidii, 338; n. sp., 338; pusillum, 338; sacchiferum, 338.
Anisanthe, 128.
Anisopogon, 94, 98.
Anomalotis, 91.
Anomochloa, 51.
Anthænantia (Aulaxanthus), 38; lanata, 39; rufa, 39; villosa, 39.
Anthephora, 62; abissynica, 62.
Anthephoreæ, 33, 32, 66; diagn. subtribe, 30.
Anthistiria, 73, 74; abyssinica, 74; anathera, 74, 143, 191; arundinacea, 74; capitata, 74; caudata, 74; ciliata, 74; fasciculata, 74; frondosa, 74; gigantea, 74, var. armata, 74; Junghuhniana, 74; minuta, 74.
Anthochloa, 119.
Anthosachne, 130.
Anthoxanthum, 76.
Antinoria, 94.
Antitragus, 57.
Antrophyum semicostatum, 296.
Apera, 90, 91; arundinacea, 81.
Apium graveolens, 245.
Apluda, 63, 74, 121; aristata, 74; mutica, 74.
Apocopis, 67, 68; himalayensis, 67; Royleanus, 67; tridentata, 67.
Apocynaceæ, Dyera, n. gen. of, 291.
Apogonia, 69.
Aquilegia sp., 150.
Arabis alpina, 152; taraxacifolia, 152.
Arachne, 107.
Aralia cachemirica, 146, 166.
Araliaceæ (Afghan), 166.
Arctagrostis, 88, 89, 125.
Arctic drift-woods, coll. by Capt. Feilden and Mr. Hart, 1875 and 1876, Prof. M'Nab on, 135; Dr. Moss's sp. of, (ftnote) 135; nature of, 138.
Arctophila, 125.
Arenaria Griffithii, 154.
Arethusa capensis, 346; ciliaris, 339; villosa, 346.
Argemone grandifolia, 245.
Argyrolobium roseum, 157.
Arisæma Jacquemontii, 188.
Aristaria, 74.
Aristella, 79, 80.
Aristida, 20, 79, 80, 142; cærulescens, 191; cynantha, 192.
Arnebia speciosa, 179.
Aroideæ (Afghan), 188.
Arrhenatherum, 98.
Arrozia, 55; micrantha, 55.
Artemisia, 147; Falconeri, 170; Roxburghiana, var. purpurascens, 170.
Arthratherum, 80.

Arthraxeæ, 64.
Arthraxon, 68.
Arthrochlæna, 107.
Arthrochortus, 130.
Arthropogon, 60, 103.
Arthrostachya, 98.
Arundinaria, 134.
Arundineæ, 31, 112; diagn. subtribe, 31.
Arundinella, 40, 59, 98; flammida, 59.
Arundo, 93, 112, 142; Donax, 147.
Asclepiadeæ (Afghan), 176.
Asperula pycnantha, 167.
Aspidium Filix-fœmina, 146; platanifolium, 295; semicordatum, var. biauriculatum, 294.
Asplenium assimile, 294; Brackenridgei, 294; Filix-fœmina, 194; ludens, 294; multilineatum, 294; obtusilobum, 294; umbrosum, var. cristovalense, 294.
Asprella, 56, 132, 134.
Aster lacunarum, 168; pseud-Amellus, 168.
Astragalus, 146, 147; Ajfreidii, 157; congestus, 158; decemjugus, 158; Hemsleyi, 158; kuramensis, 157.
Astrebla, 106.
Ataxia, 77; mexicana, 77.
Atheropogon, 104, 105, 106; affinis, 105; apludoides, 104.
Atractylis cuneata, 147.
Atropis, 126.
Aucuba japonica, repair in, 6.
Aulaxanthus, 39; ciliatus, 39; rufus, 39.
Avellinia, 116.
Avena, 96, 97, 98, 116; oligostachya, 193.
Avenaceæ, 28.
Avenastrum, 96, 97, 98.
Aveneæ, 30, 94; diagn. of tribe, 30.
Avenella, 95.
Aviceps, 341; struct. flower of, 237; pumila, 237, 342.
Axonopus, 38.

Badish-khél, veget. of, 140, 143.
Baker, J. G., Ferns coll. by Rev. R. B. Comins in Solomon Is., 293.
Baldingera, 76.
Bambusa baccifera, 134.
Bambuseæ, 21, 24, 31, 134; diagn. tribe, 31.
Bamia, Strange Marsh Mallow, 9.
Bartholina Burmanniana, 339; pectinata, 339.
Batratherum, 68.
Bauchea, 88.
Bean-plant, repair in, 3, 4.
Beckera, 56.
Beckeropsis, 49, 57.
Beckmannia, 32, 39, 47.
Beesha, 134.
Begonia sp., act. carb. ammon. on, 245.
Bentham, G., Notes on Gramineæ, 14.
Berberideæ (Afghan), 150.
Berberis vulgaris, 150.
Berchtoldia, 46; holciformis, 46; oplismenoides, 46.
Berghausia, 59.
Bergia æstivosa, 154.
Beta, act. carb. ammon. on leaves of, 278; vulgaris, 185, 245.
Betula Bhojpattra, 145.
Bignoniaceæ (Afghan), 182.
Bilabrella falciformis, 343.
Blattia, 89.
Blepharochloa, 56.
Blitum virgatum, 185.
Bluffia, 18, 42.
Blumenbachia, 19, 73.
Bœa flocculosa, 298; minahassæ, 298; Treubii, diagn. of, 297.
Boerhaavia diffusa, 184.
Boissiera, 105, 110.
Bolus, H., List of published species of Cape Orchids, 335; on structure of Cape Orchids, 233.
Bonatea bilabrella, 340; Boltoni, 340; cassidea, 340; clavata, 340; Darwinii, 340; densiflora, 340; foliosa, 340; speciosa, 340; tetrapetala, 340.
Boragineæ (Afghan), 177.
Boucerosia Aucheri, 177.
Bouteloua, 21, 62, 104, 105, 106; aristidoides, 104; disticha, 105; multiseta, 105; trialthera, 104.
Brachiaria, 34, 39, 43, 46.
Brachyactis umbrosa, 168.
Brachycorythis MacOwaniana, 346; ovata, 346; pubescens, 346; tenuior, 346.
Brachyelytrum, 78, 83.
Brachypodium, 129; distachyum, 129.
Brandtia, 59.
Brassica, act. carb. ammon. on leaves of, 278; oleracea, 245.
Briza, 116, 118, 121, 123; geniculata, 118; spicata, 123.
Brizopyrum, 123, 126; siculum, 122, 128.
Bromelica, 119, 120.
Bromidium, 91.
Bromus, 27, 116, 126, 127, 128; antarcticus, 97; ardennensis, 129; asper, 128; bicuspis, 97; Danthoniæ, 129; erectus, 128, 194; giganteus, 128; Hookeri, 129; inermis, 128;

lividus, 127; macrostachyus, 129; purgans, 129; secalinus, 129; tectorum, 127.
Brownleea cærulea, 345; macroceras, 345; parviflora, 345; recurvata, 345.
Brylkinia, 109, 121.
Bucculina, 339; aspera, 339.
Buchloe, 108, 113.
Buddleia asiatica, (ftnote) 204; auriculata, 201, 204; brachiata, (ftnote) 203; brasiliensis, (ftnote) 203; Colvillei, (ftnote) 204; crispa, (ftnote) 203; curviflora, (ftnote) 204; diffusa, (ftnote) 203; globosa, 203, 204; longifolia, (ftnote) 203; macrostachya, (ftnote) 203, 204; salviæfolia, (ftnote) 203; verticillata, (ftnote) 203.
Buddleia, Dr. Masters on Foliation and Ramification of, 201.
Bupleurum sp., 163.
Buxus, 142; sempervirens, 141, 186.

Cabrera, 36, 37, 38; chrysoblepharis, 37.
Cacalia articulata, repair in, 7.
Cactaceæ, repair in, 7.
Calamagrostis, 89, 90, 112; olympica, 89; tenella, 89.
Calamnia, 74.
Calamochloa, 113.
Calanthera, 108.
Calotheca, 122, 124.
Calotropis procera, 176.
Calycodon, 83.
Campanula aristata, 146, 174; cashmiriana, 174, var. evolvulacea, 174; ruderalis, 174.
Campanulaceæ (Afghan), 174.
Campelia, 95.
Camphorosma sp.?, 185.
Cape Orchideæ, list published sp. of, 335; struct. flower of, H. Bolus on, 233.
Capparideæ (Afghan), 152.
Capparis spinosa, 153.
Capriola, 100.
Capsella procumbens, 285.
Carb. of Ammonia on Roots of Plants, Charles Darwin on, 239.
—— —— on Chlorophyll-bodies, 262.
Carex fissirostris, 190; muricata, 190; Oliveri, 190; vulgaris, 190.
Carica Papaya, 245.
Carum meifolium, var. divergens, 163.
Caryochloa, 55, 81.
Caryophylleæ (Afghan), 153.
Castellia, 128.
Catabrosa, 116; antarctica, 111, 116; aquatica, 116; glaucescens, 116; magellanica, 116.
Cataclastos, 117, 118.
Catananche lutea, single florets on rootstock of, 288.
Catapodium, 127, 128; fusiforme, 128.
Catatherophora, 49.
Cathestechus, 62, 63.
Celosia argentea, 185.
Cenchrus, 32, 49, 61; calyculatus, 48.
Centaurea, 147.
Centotheca, 120; lappacea, 120.
Centotheceæ (subtribe diagn.), 31.
Central-African plants coll. by Major Serpa Pinto, W. P. Hiern and Prof. Count Ficalho on, abstr., 13.
Centrolepis monogyna, 286.
Centrophorum, 73.
Cephalaria syriaca, 167.
Cephalochloa, 113.
Cerastium Thomsoni, 153.
Cerasus cornuta, 142.
Ceratandra affinis, 347; auriculata, 347; chloroleuca, 347; globosa, 347; grandiflora, 347; Harveyana, 347; parviflora, 347.
Ceratochloa, 129; unioloides, 129.
Ceresia, 36, 37, 41.
Cereus, repair after amputation, 6.
Chærophyllum villosum, 164.
Chætaria, 33, 79, 80.
Chætium, 46.
Chætobromus, 99.
Chætotropis, 90.
Chæturus, 88.
Chamæcalamus, 91.
Chamædactylis, 122.
Chamæraphis, 49, 50.
Chamagrostis, 85.
Chara vulgaris, 194.
Characeæ (Afghan), 194.
Chascolytrum, 123.
Chasmanthium, 122.
Chenopodiaceæ (Afghan), 185.
Chilochloa, 85.
Chionachne, 52.
Chlorideæ, 27, 28, 100.
—— (tribe diagn.), 30.
Chloris, 101, 102, 103; aciculare, 102; divaricata, 102; foliosa, 100; macrantha, 102, 106; macrostachya, 101; monostachya, 102; pectinata, 102; pumilio, 102; radiata, 102; Roxburghiana, 102; submutica, 102; unispicea, 102; villosa, 102, 106, 143, 193.
Chlorococcum, spectroscop. analysis of, 9.

Chlorophyll-bodies, act. of Carb. of Ammonia on, 62.
Chondrachyrum, 119.
Chondrolæna, 92.
Chondrosia, 104.
Chondrosium, 104.
Chorispora Bungeana, 152.
Chrysanthemum Griffithii, 170.
Chrysanthistiria, 74.
Chrysopogon, 66, 67, 73, 74, 142; avenaceus, 73; ciliolatus, 191; Gryllus, 73; halepense, 73; Minarum, 73; nutans, 73; stipoides, 73; vulgare, 73.
Chrysurus, 114.
Ciesielski, exper. on veg., 218.
Cinna, 75, 89, 90; arundinacea, 89; expansa, 90; latifolia, 90; macroura, 87; pendula, 90; stricta, 87.
Cinnagrostis, 90.
Cinnastrum, 91.
Clarke, C. B., on a Hampshire Orchis, 206; on two Himalayan Ferns erroneously treated in the "Ferns of N. India," 289.
Classification of Crocus, G. Maw on, 348.
Cleistachne, 61.
Clematis Robertsiana, 148; orientalis, var. obtusifolia, 148.
Clinelyna, 133.
Clisanthæ, 26.
Clomena, 83.
Cnicus, 147; lanceolatus, 173; sp., 173.
Cocculus Leæba, 150.
Codonopsis, 147.
Cœlachne, 92, 93; perpusilla, 93; pulchella, 93; simpliciuscula, 93.
Cœlachryum, 117.
Cœlebogyne ilicifolia, 244.
Cœlorhachis, 68.
Coffea arabica, exper. with fungus-spores on, 310, 313; liberica, affect. by fungus, 333.
Coffee, buds, observ. on, 324; effects of season and weather on, 301, 320, 326, 328, 330; leaves, production of, and infection by fungus, 315, 316, 320; manner of growing in Ceylon, 300.
Coffee-leaf Disease, H. M. Ward on, 299.
Cohn's opinion on cell-sap, 265.
Coix, 52; heteroclita, 52.
Coleanthus, 77, 85; subtilis, 85.
Coleatænia, 45.
Colobachne, 57.
Colobanthus, 116.
Colpodium, 87, 88, 116, 125.
Comins, Rev. R. B., ferns coll. in Solomon Is. by, 293.
Commelina, 189.
Commelineæ (Afghan), 189.
Compositæ (Afghan), 168.
Conferva glacialis, 231.
Confervaceæ, 231.
Coniferæ (Afghan), 187.
Connection between Geotropism and Growth, F. Darwin on, 218.
Conringia orientalis, 152.
Contrivance for Cross-fertilization in Roscoea purpurea and Salvia Grahami. by R. Irwin Lynch, 204.
Convolvulaceæ (Afghan), 179.
Convolvulus Aitchisoni, 179.
Conyza ægyptiaca, 168.
Corchorus olitorius, 155; trilocularis, 155.
Corethrum, 105.
Coridochloa, 18, 42.
Cornucopiæ, 57.
Corycarpus, 119.
Coryciеæ, 346.
Corycium bicolor, 347; bifidum, 347; crispum, 347; excisum, 347; ligulatum, 347; microglossum, 347; nigrescens, 347; orobanchoides, 347; vestitum, 347.
Corydalis Griffithii, 151; pulchella, 151; ramosa, 145, 152.
Corynephorus, 94, 95.
Cosmarium Brebissonii, 231; pachydermum, 231.
Costia, 130.
Cotoneaster tomentosa, 162.
Cottea, 109.
Cotton, African sp. of, 212.
Cotula integrifolia, 285.
Cotyledon tenuicaulis, 162.
Cousinia, 146; aptera, 170; auriculata, 171; buphthalmoides, 171; carthamoides, 171; elegans, 172; scala, 172.
Cræpalium, 130.
Craspedorhachis, 103; pinarocephala, 171.
Crassulaceæ (Afghan), 162.
Cratægus, 145.
Cremopyrum, 130.
Crepis sp., 173.
Crinipes, 100.
Critesion, 133.
Crithe, 97.
Crithodium, 131.
Crithopsis, 133.
Crocus Adami, 358; aërius, 358, 365, 366, 370, 372; alatavicus, 364, 365, 367, 372; ancyrensis, 359, 364, 366, 372; appendiculatus, 370; asturicus, 358, 363, 366, 368, 372; aureus, 352,

354, 359, 361, 362, 364, 366, 370, 372; Balansæ, 364, 366, 372; banaticus, 364, 366, 372; biflorus, 358, 365, 366, 367, 368, 369, 370, 372; Biliottii, 364, 366, 372; Boissieri, 359, 364, 366, 372; Boryi, 364, 366, 372; Cambessedesii, 363, 366, 369, 372; cancellatus, 358, 364, 366, 367, 370, 372; candidus, 364, 366, 372; carpetanus, 354, 359, 361, 364, 366, 369, 372; caspius, 364, 367, 372; chrysanthus, 358, 361, 365, 366, 370, 372; Clusii, 363, 365, 366, 368, 372; corsicus, 364, 366, 369, 372; Crewei, 359, 365, 366, 369, 372; cyprius, 359, 365, 366, 369, 372; dalmaticus, 364, 366, 372; Danfordiæ, 365, 372; etruscus, 364, 366, 372; Fleischeri, 352, 353, 363, 365, 366, 370, 372; Gaillardotii, 364, 367, 368, 372; gargaricus, 361, 362, 364, 366, 372; granatensis, 363, 366, 368, 372; hadriaticus, 364, 366, 369, 370, 372; hermoneus, 364, 367, 372; hyemalis, 364, 365, 367, 372; Imperati, 364, 366, 372; intromissus, 368; iridiflorus, 354, 357, 361, 363, 366, 372; karduchorum, 354, 355, 363, 366, 372; Korolkowi, 364, 367, 372; lævigatus, 352, 353, 364, 366, 372; lazicus, 363, 366, 372; longiflorus, 363, 364, 366, 372; Malyi, 364, 366, 372; medius, 354, 356, 364, 366, 372; minimus, 359, 364, 366, 369, 372; montenegrinus, 364, 366, 370, 372; nevadensis, 354, 361, 364, 366, 367, 369, 372; nudiflorus, 354, 356, 363, 366, 368, 372; ochroleucus, 363, 367, 372; Olivieri, 364, 366, 372; parviflorus, 352, 363, 365, 366, 370, 372; peloponnesiacus, 354; pulchellus, 354, 358, 359, 366, 372; reticulatus, 358, 364, 366, 367, 372; Salzmannii, 363, 365, 366, 367, 368, 372; sativus, 354, 359, 361, 362, 364, 366, 367, 368, 371, 372; Scharojani, 354, 355, 363, 366, 367, 370, 372; serotinus, 352, 363, 366, 368, 372; siculus, 369; Sieberi, 364, 366, 369, 372; speciosus, 354, 366, 367, 372; stellaris, 364, 370, 372; suaveolens, 364, 366, 372; susianus, 358, 364, 367, 370, 372; Suterianus, 364, 366, 372; tauri, 365, 366, 372; Tommasinianus, 364, 366, 372; Tournefortii, 359, 364, 372; vallicola, 354, 358, 363, 366, 367, 370, 372; veluchensis, 364, 366, 372; veneris, 364, 366, 369, 372; vernus, 358, 361, 364, 366, 367, 368, 369, 371, 372; versicolor, 357, 364, 366, 372; vitellinus, 361, 362, 364, 366, 367, 372; zonatus, 354, 358, 363, 366, 367, 370, 372.

Crocus, anther of, 359; Baker's classif. of, 363; capsule of, 361; cases of mimetic variation, 358; classif. of, 348, 362; colours of, 357, 358, 369, 370; corm, reprod. of, 352; corm, struct. of, 348; filament of, 359; Fleischeri, bud-growths of, 349; geograph. distrib. of, 348, 365; Haworth's classif. of, 363; Herbert's classif. of spathe, 356; Herbert's grouping of, 363; Involucrate divis., 356, 363; lazicus, bud-growth of, 349; leaf-charac. and geograph. distrib. of, 370; leaf-sections of, 353; leaf-struct. of, 353, 354; life-hist. of, 348; Maw's classif. of, 363; nat. affinities and geograph. distrib. of, 368; Nudiflori divis., 356, 364; nudiflorus, bud-growth of, 349; perianth-struct. of, 357; pollen of, 359; scape of, 356; seed of, 362; spathes of, 356; speciosus, bud-growth of, 349; stigmata of, 359, 360; tunics, struct. of, 351.

Cross fertilization in Roscoea purpurea, 204.

Croton oblongifolium, 243.

Crozophora tinctoria, 186.

Cruciferæ (Afghan), 152.

Crypsis, 57, 84; aculeata, 57, 84; ambigua, 84; crucianelloides, 84; pygmæa, 84.

Cryptochloris, 119.

Cryptostachys, 86.

Ctenium, 101, 109; Seychellarum, 101.

Ctenopsis, 106.

Cucurbita ovifera, 245.

Cucurbitaceæ (Afghan), 163.

Cupuliferæ (Afghan), 186.

Curtopogon, 79.

Cutanda, 118, 123, 128.

Cuviera, 133.

Cyamopsis psoraloides, 157.

Cyathorhachis, 52; Wallichiana, 52.

Cycas pectinata, 245.

Cyclamen persicum, act. carb. ammon. on leaves of, 253, 254, 258, 261, 278.

Cylindrocystis Brebissonii, 231.

Cylindrostachyæ, 117, 118.

Cymbachne, 69.

Cymbella amphicephala, 231; Cessatii, 231; naviculæformis, var. altissima, 232; pisciculus, 231; stauroneiformis, 232.

Cymbidieæ, 338.

Cymbidium aculeatum, 336; pedicel-

latum, 336; plicatum, 336; Sandersonii, 338; tabulare, 336.
Cymbopogon, 63, 72, 73.
Cynodon, 19, 41, 100. 101, 107, 108; gracilis, 108; Neesii, 108; polystachyus, 108.
Cynoglossum denticulatum, 178; micranthum, var. canescens, 178.
Cynosurus, 106, 107, 114; cristagalli, 114; cristatus, 114; echinatus, 115; elegans, 115; multibracteatus, 114; polybracteatus, 114.
Cyperaceæ, 17, 18, 22, 23, (Afghan) 189.
Cyperus, 23; infraapicalis, 189; Iria, 189; niveus, 189; puncticulatus, 189.
Cyrtandreæ, on two new and one wrongly referred, by H. O. Forbes, 297.
Cyrtopera pedicellata, 336; foliosa, 337.
Czernya, 112.

Dactilon, 100.
Dactylis, 116, 123; cæspitosa, 123; glomerata, 123.
Dactyloctenium, 107, 117; ægyptiacum, 193; glaucophyllum, 107.
Dæmia extensa, 177.
Dalbergia Sissoo, 140, 160.
Danthonia, 98, 99, 106; abyssinica, 99; bipartita, 99; crispa, 99; pallescens, 99; procumbens, 99; provincialis, 99; radicans, 99, 112; Thouarsii, 99.
Darbán, vegetation valley of, 144.
Darwin, Charles, on Action of Carb. of Ammonia on Chlorophyll-bodies, 262; on Action of Carb. of Ammonia on Roots of Plants, 239.
Darwin, Francis, on Connexion of Geotropism and Growth, 218.
Datisca cannabina, repair in, 4.
Davallia Clarkii, 291; dareæformis, 291; dubia, 288.
Dendrocalameæ, diagn. subtribe, 31.
Denticula tenuis, 231.
Depilati, a divis. of Crocus, 363.
Deschampsia, 94, 95, 96; antarctica, 96; atropurpurea, 95; Berteroanum, 96; cæspitosa, 96; flexuosa, 95; holciformis, 96; kœlerioides, 96; nitida, 96.
Desmidiaceæ, 231.
Despretzia, 121.
Deyeuxia, 88, 89, 90, 91, 95; breviglumis, 91; mutica, 91; poæformis, 91.
Diachyrium, 86.
Dianthus crinitus, 153; fimbriatus, 153.
Diarrhena, 119.
Diastemanthe, 50.
Diatoma elongatum, 231; vulgare, var. subacuta, 232; gracilis, 232.
Diatomaceæ, 231.
Dichætaria, 103.
Dichanthium, 72; dichotoma, 79.
Dichelachne, 91.
Dickie, Dr. G., Notes on Himalayan Algæ, 230.
Dicliptera Roxburghii, 182.
Dicotyledones (Afghan), 148.
Didactylon, 67.
Didymocarpus flocculosa, 298; minahassæ, diagn. of, 298; Schefferi, diagn. of, 298.
idymochæta, 91.
Diectomis, 72, 74.
Dienia muscifera, 188.
Digitalis purpurea, staminiferous corolla in, 216.
Digitaria, 34, 38, 41, 43; uniflora, 35.
Digitarieæ, 27, 38.
Digraphis, 76.
Dimeria, 67, 68.
Dimorphostachys, 43.
Dinebra, 104, 106, 108; arabica, 104, 106; aristidoides, 104; curtipendula, 104.
Dioicopoa, 125.
Dionæa muscipula, effects of carb. of ammon. on, 247, 266.
Diplachne, 107, 108, 109, 111; alopecuroides, 110; fascicularis, 111; spicata, 111.
Diplaria, 42.
Diplax, 76.
Diplectrum parviflorum, 341.
Diplocea, 111.
Diplopogon, 84.
Dipogonia, 84.
Dipsacaceæ (Afghan), 167.
Dipsacus sylvestris, 245, act. carb. ammon. on leaves of, 278.
Disa aconitoides, 343; atricapilla, 344; atropurpurea, 343; attenuata, 343; barbata, 233, 234, 235, 344; brachyceras, 343; bracteata, 343; capricornis, 343; caulescens, 343; cephalotes, 344; Charpentieriana, 235, 343; chrysostachya, 342; cornuta, 342; crassicornis, 342; Draconis, 343; fasciata, 342; ferruginea, 343; filicornis, 344; flexuosa, 345; gladioliflora, 343; glandulosa, 343; gracilis, 342; graminifolia, 234, 342, 344; grandiflora, 233, 235; Harveiana, 343; hemisphærophora, 344; Huttonii, 344; lacera, 235; læta,

344; leptostachys, 344; longicornis, 342; longifolia, 342; MacOwani, 344; macrantha, 342; maculata, 343; megaceras, 342; melaleuca, 236, 344; minor, 344; modesta, 344; montana, 344; multifida, 235, 343; natalensis, 344; neglecta, 343; nervosa, 343; obtusa, 343; ovalifolia, 344; parvilabris, 344; patens, 344; patula, 343; physodes, 345; picta, 343; polygonoides, 342; porrecta, 343; prasinata, 345; propinqua, 343; pulchra, 344; racemosa, 342; reflexa, 344; Richardiana, 344; rufescens, 345; rosea, 342; sagittalis, 343; sanguinea, 344; schizodioides, 343; secunda, 236, 342; spathulata, 235, 343; stricta, 343; tabularis, 343; telipogonis, 343; tenella, 343; tenuis, 343; triloba, 343; tripartita, 343; uniflora, 342; vaginata, 344; venosa, 343; Zeyheri, 343.

Disa grandifolia, struct. column of, 233.

Disarrenum, 77.

Diseæ, 341.

Dispar, 125.

Disperis capensis, 436; cardiophora, 347; Cooperi, 347; cucullata, 346; Fanniniæ, 347; micrantha, 346; paludosa, 347; purpurata, 347; secunda, 346; stenoplectron, 347; tenera, 346; villosa, 346; Wealii, 347.

Dissanthelium, 116.

Distichlis, 122, 123.

Dodonæa, 142; viscosa, 156.

Donax, 112.

Draba alpina, 152.

Dracocephalum nodulosum, 183.

Drosera, 262, 266, 267, 272; act. carb. ammon. on, 247, 269; experiments with raw meat, 273; tentacles of, 268.

Drosophyllum, act. carb. ammon. on, 247, 259, 276; lusitanicum, 247, 275.

Dyera costulata, diagn. of, 293; Lowii, diagn. of, 293; minute flower of, 292; n. gen. of Apocynaceæ, diagn. of, 291.

Dupontia, 125.

Eatonia, 116.

Ecbalium agreste, repair in, 3, 4, 5.

Eccoilopus, 65.

Echinaria, 113.

Echinochloa (section), 33, 43, 44, 46.

Echinolæna, 50; scabra, 50.

Echinolysium, 114.

Echinopogon, 84.

Echinops echinatus, 170.

Echinospermum sp., 178.

Ectrosia, 115, 118, 119.

Edwardsia mollis, 141.

Ehrartia, 56.

Ehretia obtusifolia, 177.

Ehrharta, 76.

Elatineæ (Afghan), 154.

Electra, 124.

Eleusine, 106, 107, 116, 117; ægyptiaca, 107; brevifolia, 107; coracana, 107; glaucophylla, 107; indica, 107; macrostachya, 107; verticillata, 107.

Elionurus, 68, 142; ciliatis, 69; hirsutus, 68, 191.

Elymeæ, diagn. subtribe, 31, 133.

Elymus, 133; europæus, 133; Sitanion, 133.

Elytrigium, 130.

Elytrophorus, 113, 114.

Emprosthion, 27, 38.

Enodium, 116.

Enneapogon, 109.

Enteropogon, 101, 105; leptophylla, 101; macrostachya, 101; melicoides, 101.

Ephedra ciliata, 140, 187; sp., 186; vulgaris, 186.

Epicampes, 82, 87, 88, 90; macroura, 87; rigens, 88; stricta, 88.

Epidendreæ, 336.

Epidendrum capense, 338.

Epilobium minutiflorum, 163; roseum, 163; tetragonum, 163.

Epiphegus virginiana, 289.

Epiphora pubescens, 338.

Eragrosteæ, diagn. subtribe, 31, 115.

Eragrostis, 23, 107, 116, 118, 124; bifaria, 117; brevifolia, 117; Cœlachryum, 117; ciliaris, 117; congesta, 117; cynosuroides, 117; geniculata, 118; megastachya, 117, 118; peruviana, 117; pilosa, 117; reptans, 118; Schimperi, 117; Wightiana, 117.

Eremachyrion, 36.

Eremites, 52.

Eremochloa, 70, 109, 112.

Eremopyrum, 130, 131.

Eremostachys acanthocalyx, 184; speciosa, 184.

Eremurus Aitchisoni, 188.

Eriachne, 42, 93, 94, 96; triseta, 93.

Erianthus, 65, 66; filifolius, 67; longisetus, 67; Ravennæ, 66; saccharoides, 66; stricta, 66; versicolor, 67.

Ericaceæ (Afghan), 175.

Eriocaulon, 24.

Eriochæte, 48.
Eriochloa, 33, 39, 43, 56; annulata, 39; distachya, 39; grandiflora, 39; polystachya, 39; punctata, 39; trichopus, 39; villosa, 39.
Eriochrysis attenuata, 65; fusca, 65; longifolia, 67; Nareya, 66; pallida, 66.
Eriocoma, 82.
Eriophorum comosum, 189.
Eritrichium capituliflorum, 289; strictum, 178.
Erysimum asperulum, 152.
Euagrosteæ, diagn. subtribe, 30.
Euandropogoneæ, 70.
Eubambuseæ, diagn. subtribe, 31.
Euchlæna, 53.
Eufestuceæ, 121; diagn. subtribe, 31.
Euklastaxon, 72.
Eulalia cotulifera, 65; glabrata, 67.
Euleptochloa, 108.
Eulophia, 336; barbata, 337; capensis, 336; clavicornis, 337; cochlearis, 337; cõmosa, 337; Drègeana, 337; emarginata, 337; ensata, 337; foliosa, 337; lamellata, 337; lissochiloides, 337; Meleagris, 337; micrantha, 337; nutans, 337; odontoglossa, 337; ovalis, 337; parvilabris, 337; platypetala, 337; plicata, 337; rupestris, 337; sphærocarpa, 337; tenella, 337; tristis, 337; violacea, 337; Zeyheriana, 337.
Eunotia diodon, 231; exigua, var. paludosa, 232; gracilis, 232; monodon, 231; prærupta, 232, var. bigibba, 232, var. nubicola, 232, var. Papilio, 232; robusta, 232, var. diodon, 232.
Euonymus, 147.
Euoryzopsis, 81.
Eupanicum, 44.
Eupaspalum, 36, 37.
Euphorbia amygdaloides, 243; cœladenia, 185; indica, 185; myrsinites, 243; ornithopus, 243; rhipsaloides, 243; Thomsoniana, 147, 186.
—— Peplus, action carb. ammon. on roots of, 239, 243, 257, 258, 259.
Euphorbiaceæ (Afghan), 185.
Euryantheæ, 26.
Eustachys, 102.
Eutriana, 21, 104; affinis, 105; multisecta, 105.
Euzoysieæ, diagn. subtribe, 30.
Evolvulus alsinoides, 179.
Exotheca, 74.
Exydra, 126.
Faba vulgaris, repair in, 3, 5.
Falona, 115.
Feilden, Capt., and Mr. Hart, drift woods coll. by, 135.
Ferns, coll. by Rev. R. B. Comins in Solomon Is., J. G. Baker on, 293.
——, on two Himalayan, erroneously treated in "Ferns of N. India," 289.
Ferula communis, 147, 165.
Festuca, 2, 109, 116, 118, 124, 126, 129; ampliflora, 127; amplissima, 127; cynosuroides, 128; delicatula, 127, 128; divaricata, 118; fimbriata, 127; gigantea, 128; Hookeriana, 127; incrassata, 118; lanceolata, 118; leptothrix, 127; littoralis, 127; lolium, 128; maritima, 118; memphitica, 118; nutans, 127; scirpoidea, 127; pectinella, 106; philistæa, 118; pratensis, 127; scabrum, 130; setacea, 127; sylvatica, 127; tuberculata, 128; ulochæta, 127; unilateralis, 128; unioloides, 128; varia, 127.
Festuceæ, 28, 108; diagn. tribe, 30.
Festucoides, 127, 128.
Fibichia, 19, 100.
Ficalho, Prof. Count, and W. P. Hiern, Central-African plants coll. by Major Serpa Pinto (abst.), 13.
Ficoideæ (Afghan), 163.
Ficus Carica, 147.
Filago germanica, 169.
Filices (Afghan), 194.
Fimbristylis dichotoma, 189.
Fingerhuthia, 32, 114; africana, 142, 193.
Fiorinia, 94.
Flora of Kuram Valley, Afghanistan. Part II. By J. E. T. Aitchison, 139; the ground traversed, 140.
—— of New Zealand, recent add. to, 285.
Fluminia, 125.
Foliation and ramification of Buddleia auriculata, Dr. M. T. Masters on, 201.
Forbes, H. O., on two new and one wrongly-referred Cyrtandreæ, 297.
Forficaria graminifolia, 345.
Fragaria, act. carb. ammon. on, 251.
Fraxinus xanthoxyloides, 176.
Fuchsia-leaves, act. carb. ammon. on, 278.
Fumaria corymbosa, negative heliotropism in, 232; act. carb. ammon. on leaves of, 278.
Fungi (Afghan), 194.
Fungus of coffee-leaf disease, 299.
Fussia, 94.

Gaillonia hymenostephana, 167.
Galium Mollugo, 167; tricorne, 167.
Gamelythrum, 84.
Gamopetalæ (Afghan), 166.
Garnotia, 58, 59.
Gastridium, 90; nitens, 90.
Gaudinia, 98; fragilis, 98; geminiflora, 98.
Geaster hygrometricus, 194; minimus, 194; rufescens, 195.
Gentiana aquatica, 177; aurea, 177; Kurroo, 177; micrantha, 177.
Gentianeæ (Afghan), 177.
Geograph. distrib. Crocus, G. Maw on, 348.
Geotropism and Growth, F. Darwin on, 218.
Geraniaceæ (Afghan), 155.
Geranium collinum, 155; sp., repair in, 5.
Germainia, 74.
Glumiferæ (Afghan), 189.
Glyceria, 116, 124, 125, 126; aquatica, 126; fluitans, 126; nervata, 126; pallida, 126.
Gnaphalium pulvinatum, 169.
Gnetaceæ (Afghan), 186.
Goldbachia, 59.
Gomphonema angustatum, var., 232; tenellum, 231.
Gossypium, 58; barbadense, 213, var. acuminatum, 213; herbaceum, 154, 212; Kirkii, 213, (diagn. of) 214; sandvicense, 212; Stocksii, 212; taitense, 212.
——, geograph. distrib. of, 212; new sp. from E. Tropical Africa, 212.
Gramineæ (Afghan), 190.
——, Notes on, by G. Bentham, 14; awn, value of, 28; bad sp. of, 14; Bentham's remarks on literature of, 15–18; Brown's grouping of, 25; divis. into tribes and subtribes, 25; elucid. of ord. in local floras, 18; embryo, size &c. of, 28; Fries and Anderson's divis., 26; Fournier's groups, 27; gen. and groups disting. by combination of charac., 21, 25; geograph. distrib. of, 25; Hackel, views on palea and lodicule, 23; homology of glumes, 23; Kunth's divis., 26; lodicules of, 23, 24; Munro's arrang., 29; nature of spikelet &c., 15, 22; number of sp. as comp. with Orchideæ, 14; palea of, 23, 24; palea and lodicules = perianth-segm., 24; rudimentary staminodia in, 24; sexes, 28; substitution of names in, 19; terminology used in, 22; writers on, 15.
Graphephorum, 112, 125.
Grasses (Afghan), 142.
Graya, 93.
Green colour of hair of Sloths, H. C. Sorby on, 8.
Greenia, 58.
Greslania, 134.
Grewia populifera, 154; salvifolia, 154; villosa, 155.
Growth and Geotropism, F. Darwin on, 218.
Gymnandropogon, 66, 72, 73.
Gymnanthelia, 72.
Gymnogramme Cominsii, 296; quinata, 296.
Gymnopogon, 41, 102, 103; foliosus, 103; pullulans, 103; rigidus, 103.
Gymnostichum, 134.
Gymnothrix, 48, 142.
Gynerium, 112.
Gypsophila, 147; Stewartii, 147, 153.

Habenaria arenaria, 343; brachyphylla, 146, 188; cassidea, 340; ciliasa, 340; clavata, 340; densiflora, 340; Drègeana, 340; falciformis, 340; Gerrardi, 340; lævigata, 340; malacophylla, 340; natalensis, 340; orangana, 340; ornithopodia, 340; polypodantha, 340; Saundersiæ, 340; tetramera, 340.
Habenarieæ, 338.
Habíb-kalla, veget. of, 143.
Hair of Sloth, green colour of, 8; Algæ on, 9.
Hallackia fimbriata, 339.
Hampshire Orchis, C. B. Clarke on a, 206.
Haplachne, 67.
Hariáb district vegetation, 146.
Harpachne Schimperi, 117.
Harpechloa, 101.
Harpostachys, 42.
Hart, Mr., and Capt. Feilden, Arctic drift woods coll. by, 135.
Haynaldia, 131.
Hekaterosachne, 46.
Heleochloa, 57, 84; schœnoides, 57, 84.
Helianthus annuus, 169.
Helicotrichum, 97.
Heliotropism, negative, in Fumaria corymbosa, 232; in Linaria Cymbalaria, 233.
Heliotropium cabulicum, 177; Eichwaldi, 178.
Helleria, 127.
Helopus, 39.
Hemarthria, 69, 142; fasciculata, 191.

Hemibromus, 129.
Hemileia Canthii, 335; vastatrix, H. M. Ward on Life-history of, 299.
——, exper. growth spores of, 307; germination of spores, 302, 305; how spread, 334; in diff. Coffees, 306; ingrowth of germinal tube, 310; numbers of spores, 314; orange-col. rust, 307; spores carried by wind, 322; sporidia of, 335; teleutospores of, 335; true infective act, 302; uredospores of, 335.
Hemisacris, 124.
Henslow, Rev. G., on a Proliferous Mignonette, 214; on Staminiferous Corollas of Digitalis purpurea and Solanum tuberosum, 216.
Heracleum propinquum, 165; leucocarpum, 165.
Herminium natalense, 338.
Herschelia barbata, 236, 344; cœlestis, 234, 235, 344.
Heterachne, 119.
Heteranthelium, 131.
Heterelytron (Andersson), 74; (Jungh.), 74.
Heteropogon, 71, 142; acuminatus, 71; contortus, 71, 191; hirtus, 71; melanocarpus, 71; Roylei, 71.
Heterostega, 104.
Hevia Spruciana, 243.
Hexarrhena, 61; cenchroides, 62; Jamesii, 62; mutica, 62; sericea, 62.
Hibiscus incanus, 10; moschatus, 9, 10, 11, 12; palustris, 9, 10, 11, 12; roseus, 10; Solandra; 154; Trionum, 154.
—— palustris, Note on, by B. D. Jackson, 9.
Hiern, W. P., and Prof. Count Ficalho, Central-African plants coll. by Major Serpa Pinto, abst., 13.
Hierochloa, 77; alpina, var. submutica, 287; borealis, 287; redolens, 287.
Hilaria, 61, 62.
Himalayan Algæ, 230.
Himantidium aureus, 231; majus, 231.
Himantochæte, 99.
Holboellia, 63.
Holcus, 96; cæspitosus, 96; grandiflorus, 96.
Hologamium, 71.
Holosetum, 42.
Holostigma, a divis. of Crocus, 363.
Holothrix aspera, 339; brachylabris, 340; Burchellii, 339; condensata, 340; exilis, 339; gracilis, 339; grandiflora, 339; Harveiana, 339; incurva, 339; Lindleyana, 339; MacOwaniana, 340; Mon. ris, 339; Mundtii, 340; orthoceras, 340; parviflora, 339; pilosa, 340; Scopularia, 339; secunda, 340; squamulosa, 339; villosa, 339.
Homalachne 96
Homal ceuchrus, 56.
Homœatherum, 72.
Homoplitis, 67.
Hooker, Sir J. D., on Dyera, a new genus of Rubber-producing Plants, 291.
Hordeaceæ, 27.
Hordeæ, 28; diagn., 31, 129.
Hordeum, 133; ægiceras, 133; bulbosum, 133; crinitum, 133; jubatum, 133; murinum, 133; sylvaticum, 133; vulgare, 133.
Hoya campanulata, 245.
Huttonia Hallackii, 339; pulchra, 339.
Hyacinthus orientalis, repair in, 2, 8.
Hyalotheca dissiliens, 231; var. tridentula, 231.
Hydrocharis, roots of, 261.
Hydrochloa, 54, 126.
Hydropyrum, 54.
Hygrorhiza, 55.
Hymenothecium, 62.
Hyparrhenia, 72.
Hypericineæ (Afghan), 154.
Hypericum cernuum, 143, 154; perforatum, 154.
Hypoelytrum pungens, 24.
Hypudæurus, 62.
Hystericina, 84.
Hystrix, 134.

Ichnanthus, 40, 45, 46; Hoffmanseggii, 46; longiflora, 45; oplismenioides, 46; pallens, 45.
Impatiens amphorata, 155; brachycentra, 155; Lehmannii, 155.
Imperata, 59, 64; arundinacea, 64; caudata, 64; ramosa, 64; saccharifera, 65.
Inula rupestris, 169.
Ipnum, 118.
Ipomœa eriocarpa, 179.
Iris ensata, 144.
Isachne, 85, 92, 93; diagn. of tribe, 30; nilaghirica, 93; pulchella, 93; simpliciuscula, 93.
Isachneæ, 92.
Ischæmopogon, 71.
Ischæmum, 66, 70; insculptum, 71; latifolium, 71; laxum, 71; leersioides, 71; macrostachyum, 71; muticum, 70; ophiuroides, 71; paleaceum, 67; pectinatum, 71; semisagittatum, 70; speciosum, 70.

Iseilema, 74.
Isopyrum uniflorum, 149.
Isotria, 110; Cunninghamii, 110; Mitchelli, 110; pungens, 110.
Ixophorus, 47.

Jackson, B. D., Occurrence of Single Florets on Rootstock of Catananche lutea, 288; Note on Hibiscus palustris, Linn., and certain allied species, 9; Negative Heliotropism in Fumaria corymbosa, 232.
Jarava, 80.
Jasminum revolutum, 147.
Joachimia, 40.
Jouvea, 108.
Juncaceæ (Afghan), 189.
Juncus brevifolius, 286; communis, var. hexagonus, 286; lamprocarpus, 189; pauciflorus, 286.
Juniperus recurva, 189.
Jurinea leptoloba, 173.
Justicia peploides, 182.

Kakrasingee, 142.
Kirk, T., Recent Additions to the New-Zealand Flora, 285.
Knappia, 85.
Kobresia schœnoides, 146, 190; scirpina, 146, 190.
Kœleria, 115, 116, 123; Gerardi, 115; glomerata, 115; phleoides, 97, 115; vestita, 115.
Korycarpus, 119.
Kralikia, 133.
Krombholtzia, 121.
Ktenosachne, 92.
Kuram Valley, Flora of, 139.

Labiatæ (Afghan), 182.
Lachnagrostis, 90.
Lactuca, 147; auriculata, 173; macrorhiza, 173; rapunculoides, 174; sativa, 245; scariola, 173.
Lagurus, 92.
Lamarckia, 114.
Lamium purpureum, 245.
Lantana alba, 182.
Lappago, 62; racemosa, 191.
Lappagopsis, 38.
Larix, 135, (Arctic) 137.
Lasiagrostis, 81.
Lasiochloa, 123.
Lasiolytrum, 68.
Lasiopogon lanatum, 169.
Lasiurus, 68.
Lastrea pulvinulifera, 290.
Latipes, 62.
Launæa nudicaulis, 174; sp. nov.?, 174.

Laurineæ, 18.
Leaves, action of carb. of ammon. on, 266–284.
Leersia, 56; hexandra, 56; oryzoides, 56.
Leguminosæ (Afghan), 157.
Lemna, act. carb. ammon. on leaves of, 278.
—— sp., 245.
Leontodon Taraxacum, 246.
Lepideilema, 51.
Lepidopyronia, 106.
Leptachyrium, 49.
Leptaspis, 51.
Leptatherum, 67.
Leptocarydion, 110.
Leptochloa, 41, 106, 107, 111, 116, 122; arabica, 108; dubia, 108; fascicularis, 108; Lindleyana, 108, 111; mollis, 108, 111; Neesii, 108; plumosa, 108, 110; polystachya, 108; uniflora, 108; Wightiana, 108, 117.
Leptocoryphium lanatum, 39; molle, 39.
Leptodermis, 144.
Leptorhabdos virgata, 181.
Leptostachyæ, 117.
Leptothrium, 63.
Leptureæ, 132; diagn. subtribe, 31.
Lepturus, 69, 132; cylindricus, 132; filiformis, 132; incurvata, 132; pannonicus, 132; paniculatus, 103; persica, 132; repens, 132; subulatus, 132.
Lerchenfeldia, 95.
Lesourdia, 20, 111.
Libertia, 129.
Life-history of a Crocus, and classif. and geograph. distrib. of genus, by G. Maw, 348.
—— —— of Hemileia vastatrix, by H. M. Ward, 299.
Liliaceæ (Afghan), 188.
Limnas, 58.
Limnetis, 50.
Limodorum barbatum, 337; longicorne, 338; triste, 337.
Linaria Cymbalaria, negative heliotropism in, 233; ramosissima, 180.
Liparideæ, 336.
Liparis, 336; capensis, 336; Bowkeri, 336.
Lippia nodiflora, 182.
Lissochilus æqualis, 337; clitellifer, 337; Krebsii, 337; parviflorus, 337; platypetalus, 337; speciosus, 337; streptopetalus, 337.
List published species of Cape Orchideæ, by H. Bolus, 335.
Lithachne, 51.

Lithagrostis, 52.
Logania, stipules in, 202.
Loganiaceæ, charac. criticised by Dr. Masters, 201.
Lolium, 130; rigidum, 130; strictum, 130; temulentum, 130.
Lomaria vulcanica, 294.
Lophatherum, 119.
Lophochlæna, 121.
Lophochloa, 115.
Lopholepis, 63.
Lophotherum, 120.
Lotus tenuifolius, 157.
Loudetia, 98.
Lucæa, 68.
Luziola, 55; alabamensis, 55; brasiliensis, 55; longivalvis, 55; micrantha, 55; peruviana, 55; Spruceana, 55.
Lychnis cabulica, 153.
Lycoperdon cælatum, 195.
Lycopsis arvensis, 178.
Lycopus europæus, 182.
Lycurus, 83.
Lygeum, 51.
Lygodium dichotomum, 297; trifurcatum, 297.
Lynch, R. I., on Contrivance for Cross-fertilization in Roscoea purpurea, 204.
Lythrarieæ (Afghan), 162.
Lythrum salicaria, 162.

M'Nab, Prof., Note on Abies Pattonii (Jeffrey MSS., 1851), 208; on Arctic Drift Woods, 135.
Macroblepharus, 117.
Macropteris, 45.
Maillea, 84.
Maize, Wiesner's exper. on, 220.
Malána, vegetation valley of, 144.
Mallopetalum, 127.
Maltebrunia, 55; leersioides, 55; prehensilis, 55.
Malvaceæ (Afghan), 154.
Mammillaria, repair in, 7.
Mandelorna, 72.
Manihot Glaziovi, 243.
Manisuris, 69.
Marshall Ward on Coffee-leaf Disease, 299.
Marsilea quadrifoliata, 194.
Marsileaceæ (Afghan), 194.
Masters, Dr. M. T., Foliation and Ramification of Buddleia auriculata, 201; new Species of Gossypium from E. Tropical Africa, 212.
Matrella, 63.
Maw, G., Notes on Life-history of a Crocus, and Classification and Geographical Distrib. of the Genus, 348.
Maydeæ, 28 (diagn., 29), 32, 51.
Megalachne, 98.
Megastachya, 118.
Megastachyæ, 117.
Melanocenchrus, 62, 105.
Melica, 119, 120; gracilis, 192; stricta, 119.
Meliceæ, 115, 118, 119, (diagn.) 31.
Melinis, 58, 60.
Meliosaccharum, 59.
Melocalamus, 134.
Melocanna bambusoides, 134.
Melocanneæ (diagn.), 31.
Melosira nivalis, 231; Roeseana, var., 232.
Menispermaceæ (Afghan), 150.
Mentha australis, 285.
Meoschium, 71.
Mercurialis perennis, 243; act. carb. ammon. on leaves of, 279.
Merisachne, 110.
Merostachys capitata, 134.
Mertensia echioides, 178.
Mesosetum, 42.
Mibora, 85.
Michelaria, 129.
Micraira, 93.
Microchloa, 100, 101.
Microlæna, 56, 76.
Micropteris, 45.
Micropyrum, 127.
Microstegium, 67.
Microthuarea, 50.
Mignonette, on Proliferous form of, by Rev. G. Henslow, 214.
Miliaria, 17, 44.
Milium, 33, 81, 82, 85, 90, 92, 93; lanatum, 39.
Miquelia, 59.
Mirabilis Jalapa, act. carb. ammon. on leaves of, 279.
Miscanthus, 59, 64; cotulifera, 65; fuscus, 65; saccharifer, 65.
Mnesithea, 69.
Molinia, 111, 116.
Monacather, 99.
Monachyrion, 96.
Monadenia, 235; brevicornis, 345; comosa, 345; densiflora, 345; inflata, 345; lancifolia, 345; leptostachya, 345; macrocera, 345; macrostachya, 345; micrantha, 345; multiflora, 345; ophrydea, 345; prasinata, 345; rufescens, 345.
Monandraira, 95.
Monanthochloe, 113.
Monerma, 132.
Monocera, 101.

Monochæte, 103.
Monochlamydeæ (Afghan), 184.
Monocotyledones (Afghan), 187.
Monopogon, 98.
Montris, 339; secunda, 339.
Muehlenbergia, 78, 81, 82, 90; clomena, 83; comata, 83; diffusa, 82, 83; gracilis, 83; nana, 83; rariflora, 81; sylvatica, 83.
Munroa, 113.
Mygalurus, 127.
Myosotis sylvatica, 178.
Myriachæta, 60.
Myriophyllum elatinoides, 285; variæfolium, 285; verrucosum, 285.
Myriostachya, 117.
Mystacidium, 338; filicorne, 338; gracile, 338; pusillum, 338.

Nannorrhops, 143; Ritchieana, 140,187.
Nardurus, 128; montanus, 128.
Nardus, 132.
Nassella, 82.
Navicula bisulcata, 231, 232; borealis, 231,var. subserians, 232; Brebissonii, var., 232; cryptocephala, 231; divergens, var. glacialis, 232; divergentissima, 232; firma, 231; gracillima, 231; mutica, 232; subcapitata, 231.
Negative heliotropism in Fumaria corymbosa, by B. D. Jackson, 232.
Nemastachys, 67.
Nepenthes, act. carb. of ammon. on, 276.
Nepeta pinetorum, 183; pubescens, 183; spicata, 183.
Nephelochloa, 124.
Nephrodium, act. carb. ammon. on leaves of, 278.
—— amboinense, 295; amboinense, var. subglandulosum, 295; Buchanani, 290; decurrens, 296; glandulosum, 295; Harveyi, 295; hederæfolium, 295; pulvinuliferum, 290; macrosorum, 295; molle, 245; pica, 295; sparsum, var. squamulosa, 290; truncatum, 295.
Nettle, act. carb. ammon. on, 245.
Neurachne, 63.
New-Zealand flora, recent additions to, by T. Kirk, 285.
New species of Gossypium from E. Tropical Africa, by Dr. M. T. Masters, 212.
Nicotiana tabacum, act. carb. ammon. on leaves of, 279.
Notes on Abies Pattonii (Jeffrey MSS., 1851), by Prof. M'Nab, 208.
—— Algæ from the Himalayas, by Dr. G. Dickie, 230.
Notes on Gramineæ, by G. Bentham, 14.
—— Hibiscus palustris, by B. D. Jackson, 9.
—— Life-hist. of a Crocus, classif. and distrib. of genus, by G. Maw, 348.
—— two Himalayan Ferns erroneously treated in the "Ferns of N. India," by C. B. Clarke, 289.
Nowodworskya, 59.
Nyctagineæ (Afghan), 184.

Occurrence of Single Florets on Rootstock of Catananche lutea, by B. D. Jackson, 288.
Ochlandra, 24, 134.
Odontidium hiemale, 231; mesodon, 231, 232.
Odontostigma, a divis. of Crocus, 363.
Œdipachne, 39.
Œdogoniaceæ, 231.
Œdogonium, 231.
Olea, 142.
Oleaceæ (Afghan), 175.
Olyra, 51.
Ommatodium, 346; volucris, 346.
Omphalodes microcarpum, 178.
Onagrarieæ (Afghan), 163.
On Dyera, n. gen. Rubber-producing plants, belonging to nat. order Apocynaceæ, from Malayan Archipelago, by Sir J. D. Hooker, 291.
Onobrychis, 146; cornuta, 147; dasycephala, 159; laxiflora, 159; spinosissima, 147.
Onoea, 119.
Onosma stenosiphon, 179.
On two new, and one wrongly referred, Cyrtandreæ, by H. O. Forbes, 297.
Ophioglossum vulgatum, 143, 194.
Ophiurus, 69, 132, 133; æthiopica, 69; corymbosa, 69; lævis, 69; monostachya, 69; undulata, 69.
Ophrydeæ, 338.
Ophrys alaris, 346; atrata, 347; bivalvata, 344; catholica, 346; patens, 344; volucris, 346.
Opisthion, 36, 37.
Opizia, 108.
Oplismenus, 33, 40, 44, 46.
Opuntia boliviensis, 245.
——, repair of amputation in, 7.
Orchideæ (Afghan), 188.
——, 14; Cape, list of published species of, 335; structure of, 233.
——, number of sp. as comp. with Gramineæ, 14; caudicles as a charac., 235.
Orchis barbata, 344; bicornis, 341; Burmanniana, 339; circumflexa, 346;

coccinea, 347; cornuta, 342; Draconis, 343; filicornis, 344; flexuosa, 345; foliosa, 340; incarnata (*L.*), 206, 207; incarnata (*L.*) var., 206; incarnata (*Syme*), 206; latifolia (*L.*), 206; pectinata, 339; sagittalis, 343; secunda, 340; speciosa, 340; tenella, 343; tripetaloides, 343.
Oreobolus, 23.
Oreochloa, 109, 118.
Ornithocephalochloa, 50.
Orobanchaceæ (Afghan), 181.
Orobanche, 181; Epithymum, 181.
Orobancheæ, 181.
Oropetium, 133.
Ortachne, 79; retorta, 79.
Orthocladia, 120.
Orthopogon, 46.
Orthoraphium, 80.
Orthosira orichalcea, 231.
Orygia decumbens, 163.
Oryza, 56; coarctata, 56; sativa, 56.
Oryzeæ (diagn. 29), 32, 53.
Oryzopsis, 33, 78, 81, 82, 92.
Otachyrium, 45.
Othonnopsis intermedia, 147.
Oxalis acetosella, act. carb. ammon. on leaves of, 251, 278; corniculata, 251; sensitiva, 251; sepium, 251.
Oxyanthe, 49.
Oxydenia, 107.
Oxygraphis Shaftoana, 149.
Oxytropis glacialis, 159.

Pachites, 342; appressa, 342.
Pachypterygium brevipes, 152.
Padia, 56.
Palmaceæ (Afghan), 187.
Panicaceæ, diagn. of series, 29; divis. of, 31, 32, 35; remarks on charac. of, 31.
Panicastrella, 113.
Paniceæ, 26, 27, 28, (diagn. 29), 32, 33, 61.
Panicum, 27, 32, 33, 39, 40, 92, 142; adspersum, 43; ansatum, 42; antidotale, 190; argenteum, 43; bellum, 93; colonum, 39, 43; crus-galli, 43, 46; decumbens, 42; exaratum, 42; ferrugineum, 42; flavidum, 43; fluitans, 43; Gayanum, 42; Gardneri, 93; gracile, 43; helopus, 39, 43; indicum, 40; ignoratum, 39; leucophæum, 42; longiflorum, 45; malaccense, 93; maximum, 190; monostachyum, 42; myurus, 44; pabulare, 142, 190; pappophorum, 42; parviflorum, 42; paspaloides, 43; Petiveri, 43; petræum, 42; platycarphum, 41; plicatum, 44; polyphyllum, 43; pterygodium, 45; roseum, 60; rottboellioides, 42; rufum, 39; sanguinale, 41, 142, 143, 190; semialatum, 18, 42, 43; subfalcatum, 42; sulcatum, 44; teneriffæ, 45; tenuiflorum, 41; thrasyoides, 42; uncinatum, 45.
Panicum, number species of, 40.
Pantathera, 128.
Papaver nudicaule, 146, 151.
Papaveraceæ (Afghan), 151.
Pappophoreæ, (diagn.) 30, 109.
Pappophorum, 109, 142; Aucheri, 193.
Paratheria, 49.
Pariana, 20, 24, 51.
Paspala, 36.
Paspalum, 27, 34, 39, 41, 43, 100; amazonicum, 35; aureum, 37, 38; brevifolium, 41; cæspitosum, 35; candidum, 36; chrysoblephare, 35; chrysoblepharis, 37; chrysodactylon, 35; cymbiforme, 37; densiflorum, 35; dissectum, 35; dissitiflorum, 38; distachyum, 35; distichum, 34; divergens, 35; exasperatum, 37; fastigiatum, 38; filifolium, 35; furcatum, 35; humile, 35; immersum, 37; lanatum, 39; maculosum, 35; malacophyllum, 35, 36, 37; maritimum, 36; minutiflorum, 41; notatum, 35; pallidum, 36; platycaulon, 35; plicatulum, 35; pumilum, 35; repens, 37; saccharoides, 38; scoparium, 35; senescens, 38; sesquiglume, 36; stoloniferum, 37; subsesquiglume, 35; surinamense, 35; tropicum, 35; vaginatum, 34, 35.
——, numbers of, 35; synonyms sp. of, 35; subdiv. of, 35.
Pastinaca sativa, 245.
Pavetta, exper. with angustifolia, 335; indica, 335.
Peas, Wiesner's exper. on, 220.
Pechea, 84.
Pectinaria, 71.
Pedalineæ (Afghan), 182.
Pedicularis bicornuta, 181; pycnantha, 181; sp., 181.
Pelargonium zonale, act. carb. ammon. on leaves of, 249, 279; repair in, 5.
Pelligeri, divis. of Crocus, 363.
Peltophorus, 68.
Penium digitus, 231.
Pennisetum, 47, 48, 49, 57, 142; Benthamianum, 48; flaccidum, 48; lanatum, 48; macrostachyum, 49; orientale, 190; tristachyum, 49; (Beckeropsis) unisetum, 47; unisetum, 49.

Pentacraspedon, 84.
Pentameris, 99.
Pentapogon, 91.
Pentaschiste, 99.
Pentatropis spiralis, 177.
Penthea, 342; atricapilla, 236, 344; filicornis, 344; filiformis, 236; melaleuca, 236, 344; minor, 344; obtusa, 236, 344; patens, 236, 344; reflexa, 236, 344; triloba, 344.
——, habit and struct., 236.
Periballia, 95.
Perieilema, 83.
Periploca hydaspides, 140, 176.
Perobachne, 74.
Perotis, 63.
Pertya Aitchisoni, 173.
Petaloideæ (Afghan), 187.
Peyritschia, 96.
Pfeffer's views on cell-sap, 265.
Phacelura, 68.
Phæcasium lampsanoides, 173.
Phænosperma, 59; globosa, 59.
Phæochloa, 127.
Phagnalon niveum, 169.
Phalarideæ, 75; diagn., 30.
Phalaridium, 116.
Phalaris, 75, 76, 84; americana, 76; arundinacea, 76; canariensis, 76, 245; crypsoides, 84; intermedia, 76; Michelii, 85; minor, 142; paradoxa, 76; trigyna, 85.
Phalona, 115.
Pharus, 51.
Phaseolus Mungo, 160.
Phippsia, 85, 86.
Phleoideæ, (diagn.) 30, 83.
Phleum, 57, 84, 85, 142; tenue, 85.
Phlomis lamiifolia, 184.
Phœnix sylvestris, 140; dactylifera, 140.
Pholiurus, 68, 132.
Phragmites, 112, 142; communis, 193.
Phyllanthus compressus, 243.
Phyllorhachis, 50.
Physalis minima, 180.
Picea (Arctic), 135, 137.
Pimpinella, 164; tripartita, 164.
Pinguicula, act. carb. ammon. on, 276.
Pinus (Arctic), 135; excelsa, 144; halipensis, 143, 144, 187; (§ Tsuga) Hookeriana, 212; longifolia, 142, 143, 187; (§ Tsuga) Pattoniana, 212; sp., 135.
Piptatherum, 17, 81; sp., 191.
Piptochætium, 82.
Pistacia integerrima, 142, 156; mutica, 156, var. cabulica, 156; sp., 156.
Pisum sativum, 147, 160.
Plagiolytrum, 105.
Plagiosetum, 49.
Plagiostachya, 117.
Planotia, 109.
Platylepis, 24.
Platystachya, 118, 123.
Pleopogon, 83.
Pleuraphis, 61, 62; Jamesii, 62; mutica, 62; sericea, 62.
Pleurococcus Bradypi, 9; Cholœpi, 9.
Pleuroplitis, 68.
Pleuropogon, 121.
Pleurospermum, 147; n. sp.?, 164; pulchrum, 164.
Plintanthus, 99.
Pluchea lanceolata, 169.
Plumbagineæ (Afghan), 175.
Poa, 89, 108, 116, 121, 124, 125, 126; albida, 125; alpina, 89; annua, 193; chilensis, 125; lanuginosa, 124, 125; mucronata, 117; persica, 124; pratensis, 124; sicula, 122, 123.
Poaceæ, (diagn.) 30, 32, 36, 75.
Podagrostis, 91.
Podophorus, 128.
Podosæmum, 83.
Pogonantherum, 64; contortum, 67.
Poidium, 125.
Poinsetta pulcherrima, 243.
Polanisia viscosa, 152.
Pollinia, 65, 66, 67, 73; articulata, 67; aurea, 67; eriopoda, 67; glabrata, 67; filifolius, 67; imberbis, 67; lancea, 67; longisetus, 67; nuda, 67; versicolor, 67; Willdenowianum, 67.
Polyantherix, 133.
Polygonaceæ (Afghan), 185.
Polygonatum multiflorum, 189.
Polygonum aviculare, 185, var. bistorta, 146, 185; cognatum, 185; flaccidum, 185; prostratum, 286; sp., 185.
Polyodon, 105; distichum, 105.
Polypetalæ (Afghan), 148.
Polypodium affine, 296; dareæforme, 291; linguæforme, 296; nigrescens, 296.
Polypogon, 19, 58; elongatus, 59.
Polyporus pinicola, 194.
Polyrhaphis, 109.
Polystachya capensis, 338; Gerrardi, 338; Lindleyana, 338; pubescens, 338; Sandersoni, 338; similis, 338.
Polytoca, 52; bracteata, 52; macrophylla, 52; Wallichiana, 52.
Pommereulla, 109.
Ponceletia, 50.
Populus (Arctic), 138; sp. near tremula, 138.
Porroteranthe, 126.
Potamochloa, 55.

Potamophila, 55; leersioides, 55; parviflora, 55; prehensilis, 55.
Primula acaulis, act. carb. ammon. on, 253; denticulata, var. capitata, 175; rosea, var., 175; sinense, act. carb. ammon. on, 278.
Primulaceæ (Afghan), 175.
Prionachne, 92.
Proliferous Mignonette, Rev. G. Henslow on a, 214.
Prunus Padus, 142.
Psamma, 91.
Psammelyna, 133.
Pseudoceresia, 36, 37; aureum, 37; cymbiforme, 37; repens, 37; stoloniferum, 37.
Pseudocynodon, 108.
Pseudopoa, 124.
Pseudosecale, 131.
Pseudostachyum compactiflorum, 134.
Psilopogon, 68.
Psilostachys, 67.
Psilotum complanatum, 297.
Psilurus, 132.
Pterium, 114.
Pteroëssa, 117, 118.
Pterygodium acutifolium, 346; alatum, 346; atratum, 347; caffrum, 346; carnosum, 346; catholicum, 346; cruciferum, 346; inversum, 346; platypetalum, 346; venosum, 346; volucris, 346.
Pterygostachyum, 67.
Ptilagrostis, 81.
Ptychophyllum, 44.
Puccinellia, 126.
Pulicaria vulgaris, 169.
Punica granatum, 163.
Putoria, 144.
Pyrus aucuparia, 162.

Quercus dilatata, 186; Ilex, 142; semecarpifolia, 145.

Rabdochloa, 108.
Raddia, 51.
Rægneria, 130.
Ranunculaceæ (Afghan), 148.
Ranunculus acris, 245; afghanicus, 148; aquatilis, 149; Aucheri, 149; Cymbalaria, 149; demissus, 149.
Raspailia, 59.
Ratzeburgia, 69.
Reana, 53.
Reboulea, 116.
Reimaria, 27, 34; aberrans, 34; oligostachya, 34.
Relchela, 91.
Reparative Processes in Vegetable Tissues, S. G. Shattock on, 1.
Report on Arctic Drift Woods coll. by Capt. Feilden and Mr. Hart, by Prof. M'Nab, 135.
Reptonia, 142.
Researches on Life-history of Hemileia vastatrix, by H. Marshall Ward, 299.
Reseda odorata, var. prolifera alba, (ftnote) 214.
Reynaudia, 24, 60.
Rhamneæ (Afghan), 155.
Rhamnus persica, 142, 156.
Rhaphis, 73.
Rhizocephalus, 84.
Rhododendron afghanicum, 146, 175; Collettianum, 175.
Rhombolytrum, 111.
Rhus, 142; Cotinus, 141, 156.
Rhynchelytrum, 45, 60; grandiflorum, 60; ruficomum, 60.
Rhynchosia aurea, 160; minima, 160.
Ripidium, 66.
Ricinus communis, 186.
Robinia-leaves, act. carb. ammon. on, 278.
Rochelia stylaris, 178.
Roemeria, 119.
Roots, F. Darwin's exper. on, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229; action of carb. of ammonia on, 239, 242, 257, carb. soda on, 241; fuchsine on, 241; glycerine on, 242; nitrate ammon. on, 241; osmic acid on, 241; phosp. ammon. on, 241.
Rootstock of Catananche lutea, 288.
Rosa anserinæfolia, 161; Beggeriana, var. genuina, 161; Ecæ, 161; Eglanteria, 161; moscheutos, 11; Webbiana, var. genuina, 161, var. microphylla, 161.
Rosaceæ (Afghan), 160.
Roscoea purpurea, contrivance for cross-fertilization in, 204.
Rottboellia, 64, 68, 132; digitata, 68; hirsuta, 68; lævis, 69; muricata, 68; myurus, 68; perforata, 69; rugosa, 68; Sandorii, 69.
Rubiaceæ (Afghan), 166.
Rubus niveus, var. Aitchisonii, 161; purpureus, 161.
Rytidospermum, 96.

Sacchareæ, 38, 64.
Saccharum, 45, 65, 142; cayennense, 66; Griffithii, 143, 191; longifolia, 66; Nareya, 66; pallida, 66; Sara, 191.
Saccidium, 339; pilosum, 340.
Sachs, opinion on Geotropism, 219, 229.

Sageretia Brandrethiana, 156.
Salicineæ (Afghan), 186.
Salix, sp., 186.
Salsola Kali, 185.
Salvadora oleoides, 176.
Salvadoraceæ (Afghan), 176.
Salvia pumila, 183; Grahami, struct. of, with ref. to Roscoea, 204.
Samolus Valerandi, 176.
Santia, 19, 58.
Sapindaceæ (Afghan), 156.
Sarcantheæ, 338.
Sarracenia purpurea, act. of carb. of ammon. on pitchers of, 248, 277, 278.
Satyridium, 341; rostratum, 342.
Satyrium aculeatum, 336; acuminatum, 341; appressa, 342; bicallosum, 342; bracteatum, 341, 342; candidum, 341; capense, 336; carneum, 341; cassideum, 341; cordifolium, 342; coriifolium, 341; cristatum, 342; cucullatum, 341; densiflorum, 341; erectum, 341; eristomum, 341; foliosum, 341; humile, 341; ligulatum, 341; lineatum, 342; longicauda, 341; longicolle, 341; lupulinum, 341; macrophyllum, 341; maculatum, 341; membranaceum, 341; militare, 341; muticum, 342; odorum, 342; papillosum, 341; parviflorum, 341; pedicellatum, 336; pictum, 342; pumilum, 237, 238, 342; pustulatum, 341; pygmæum, 342; retusum, 341; rhynchanthum, 342; sphærocarpum, 341; stenopetalum, 341; tabulare, 336; triste, 337; utriculatum, 342.
——, struct. flower of, 238.
Saussurea candicans, 173.
Savastana, 77.
Saxifraga (Afghan), 162; afghanica, 162; Stracheyi, 162; umbrosa, act. carb. ammon. on leaves of, 248.
Saxifrageæ, 162.
Scabiosa, 146; afghanica, 168; arvensis, 168; Candolliana, 168.
Schaffnera, 63.
Schedonnardus, 41, 103.
Schedonorus (*Beauv.*), 127.
Schellingia, 62.
Schismus, 116, 124.
Schistachne, 80.
Schizachyrium, 72.
Schizochilus Zeyheri, 346.
Schizodium arcuatum, 345; clavigerum, 345; flexuosum, 345; Gueinzii, 345; inflexum, 345; longipetalum, 345; obliquum, 345; obtusatum, 345; rigidum, 345.
Schizostigma, divis. of Crocus, 363.
Schmidtia, 85, 110; utriculosa, 85.
Schœnefeldia, 100.
Schœnodorus (*Griseb.*), 128.
Schubertia graveolens, 245.
Schultesia, 102.
Scirpus arenarius, 289; atropurpureus, 189; juncoides, 189; maritimus, var. macra, 189; subulatus, 189.
Sclerachne, 52, 58.
Sclerochloa, 123, 128.
Scleropoa, 118, 128.
Scleropogon, 20, 111.
Scolochloa, 112, 125.
Scopularia, 339; Burchellii, 339; grandiflora, 339; secunda, 339.
Scrophularia petræa, 180; Scopolii, 183; sp., 180.
Scrophularineæ (Afghan), 180.
Scutellaria glutinosa, var.?, 183; multicaulis, 184.
Secale, 131; fragile, 131; montanum, 131; villosum, 131.
Sedum adenotrichum, 162; heterodontum, 162; pachyclados, 162.
Sehima, 71.
Selaginella radicata, 297.
Senecio pedunculatus, 170.
Senitis, 121.
Serapias capensis, 337.
Serpa Pinto, Major, Central-African Plants coll. by (abst.), 13.
Serrafalcus, 129.
Sesamum indicum, 182.
Sesbania aculeata, 157.
Sesleria, 108, 113, 114, 188; tenella, 114.
Seslerieæ, (diagn.) 27, 31.
Setaria, 32, 40, 44, 46; glauca, 47; italica, 47; longiseta, 47, 49; viridis, 47.
Shattock, S. G., Reparative Processes in Vegetable Tissues, 1.
Sieglingia, 110.
Silene, n. sp.?, 153.
Singlingia, 19.
Siphonaceæ, 230.
Sitanion, 133.
Sium angustifolium, 163.
Sloths, green-coloured hair of, 8.
Solanaceæ (Afghan), 79.
Solanum capsicastrum?, act. carb. ammon. on, 252; coagulans, 179; gracilipes, 179; tuberosum, staminiferous corolla in, 216; xanthocarpum, 179.
Solenachne, 50.
Solomon Islands, ferns of, 293.
Sonchus sp., 245.
Sorby, H. C., On the Green Colour of the Hair of Sloths, 8.
Sorghum, 19, 73, 96; tropicum, 61.
Spartina, 50.
Sphenopus, 116.

Spinifex, 50.
Spiræa brahuica, 160.
Spirogyra crassa, action carb. of ammon. on, 259, 282.
Spodiopogon, 65, 66, 73; albidus, 66; angustifolius, 66, 67; foliata, 66; pogonanthus, 66; sibiricus, 66.
Sporidia of Hemileia, 335.
Sporoboleæ (diagn.), 30.
Sporobolus, 59, 77, 84, 85, 86, 87, 92; compressus, 86; indicus, 86; serotinus, 86; virginicus, 86, 95.
Staminiferous corollas of Digitalis purpurea and Solanum tuberosum, Rev. G. Henslow on, 216.
Stapelia, act. carb. ammon. on leaves of, 278; hamata, 245.
Staphylea Emodi, 156.
Statice Griffithii, 142, 175.
Staurastrum, 231.
Stauroneis anceps, 231; anceps, var., 232; gracilis, 231; platystoma, 231; producta, var. subproducta, 232.
Stellaria glauca, 153; Kotschyana, 154.
Stenobromus, 127, 128.
Stenochloa, 116.
Stenoglottis fimbriata, 339.
Stenotaphrum, 33, 50.
Stipa, 24, 28, 78, 80, 81, 82, 145; altaica, 80; arenaria, 80; aristella, 80; arundinacea, 81; Calamagrostis, 81; eriostachys, 80; jarava, 80; micrantha, 287; mongholica, 81; papposa, 80; pennata, 81; Petriei, 288; rariflora, 81; Redowskii, 80; setacea, 288; sibirica, 80; sp., 191; tenacissima, 80; verticillata, 81.
Stipagrostis, 80.
Stipeæ (diagn.), 30.
Stipules, nature of, in Buddleia, 202; morphology and growth of, 203.
Strange Marsh-Mallow, 9.
Strephium, 51.
Streptachne, 79.
Streptochæta, 51, 99.
Streptogyne, 120.
Sturmia, 85; capensis, 336.
Suardia, 60.
Surirella biseriata, 231; linearis, 231.
Syllepis, 64.
Synedra lunaris, 231; oxyrhynchus, 231.
Syntherisma, 41.

Tabellaria flocculosa, 231.
Tanacetum, 147; Fisheræ, 170.
Taxus (Arctic), 138; baccata, 245; sp., 138.
Tecoma undulata, 182.
Teleutospores of Hemileia, 335.
Tephrosia pauciflora, 157.
Tetmemorus granulatus, 231.
Tetrachne, 106.
Tetrapogon, 102, 106.
Tetrarrhena, 76.
Teucrium, 141; incanum, 184; Scordium, 184.
Thal, veget. of, 140.
Thalictrum minus, var. majus, 148.
Thamnocalamus, 134.
Thelepogon, 70.
Themeda, 73.
Thouarea, 50.
Thrasya, 42; paspaloides, 42.
Thuarea, 50.
Thurberia, 58.
Thyridostachyum, 69.
Thysanachne, 59.
Thysanolæna, 60.
Tiliaceæ (Afghan), 154.
Tinæa, 114.
Torresia, 77.
Tosagris, 83.
Tozzettia, 57.
Trachynia, 129.
Trachynotia, 50.
Trachyozus, 62.
Trachypogon, 71; scrobiculatus, 71.
Trachys, 62.
Trachystachys, 62.
Tradescantia, 264; phenom. in hairs of, 264.
Tragus, 62.
Triachyrium, 86.
Triæna, 104.
Triarthera, 104.
Tribulus terrestris, 155.
Trichachne, 38, 41, 45.
Trichæta, 97.
Trichloris, 20, 102, 103, 105, 110; fasciculata, 103.
Trichochilia, 233.
Trichochloa, 83.
Trichodesma strictum, 178.
Trichodium, 88.
Trichodon, 112.
Tricholæna, 41, 44, 45.
Trichoneura, 111.
Trichopteryx, 59, 98; flammea, 98.
Tricuspis, 110.
Trifolium repens, 245.
Trillium Govanianum, 146, 188.
Triniusa, 129.
Triodia, 19, 99, 108, 110, 116; albescens, 111; antarctica, 111; filiformis, 111; kerguelensis, 111; plumosa, 110, 111; trinerviglumis, 111.
Triodieæ, (diagn.) 30, 110.
Triplachne, 87, 90.
Triplasis, 111; setacea, 111.
Triplathera, 105.

Tripogon, 105, 117; abyssinicus, 106; bromoides, 128.
Tripsacum, 52.
Triraphis, 99, 105, 112; capensis, 112; microdon, 112; mollis, 112.
Triscenia, 60.
Trisetaria, 91, 92.
Trisetum, 96; ariæforme, 95; antarcticum, 97; Berteroanum, 95; distichophyllum, 97; hirtum, 97; neglectum, 97; ovatum, 97; subspicatum, 97.
Trisiola, 122.
Tristachya, 98; simplex, 98.
Tristegineæ, 28, 33, 57, (diagn.) 29.
Tristegis, 58, 60.
Triticeæ, 130, (diagn.) 31.
Triticum, 131; bicorne, 131; bœoticum, 131; monococcum, 131.
Trochera, 76.
Tropæolum-leaves, act. carb. ammon. on, 278.
Tryphia, 339; major, 340; orthoceras, 340; secunda, 339; parviflora, 339.
Tsuga Balfouriana, 211.
Tylothrasya, 42.
Typha angustifolia, 188; latifolia, 188; Martini, 188.
Typhaceæ (Afghan), 188.
Typhoides, 76.

Umbelliferæ (Afghan), 163.
Uniola, 21, 109, 122, 129; prostrata, 122; racemiflora, 122; virgata, 122.
Urachne, 81.
Uralepis, 110; cornuta, 111; purpurea, 111.
Uredospores of Hemileia, 301, 335.
Urochlæna, 113.
Urochloa, 32, 42, 43, 47; uniseta, 47.
Urtica, act. carb. ammon. on, 245.

Vahlodea, 95.
Valeriana sisymbriæfolia, 167.
Valerianeæ (Afghan), 167.
Valerianella sclerocarpa, 167.
Vandeæ, 336.
Van Tieghem on protoplasm in cells, (ftnote) 264.
Vaseya, 83.
Vaucheria, 230; cell-repair of, 2.
Vegetable tissues, reparative processes in, 1; after amputation, 2; after artificial union, 2; after incision, 2.
Vegetation between Badish-khél and Habíb-kalla, 143; Hariáb district, 146; Thal and Badish-khél, 140; valleys of Zérán, Malána, and Darbán, 144.
Ventenata, 97; avenacea, 97; macra, 97.
Verbenaceæ (Afghan), 182.
Veronica Anagallis, 180; biloba, 180; cardiocarpa, 180; rupestris, 180.
Vetiveria, 72; arundinacea, 72.
Vicia faba, Darwin's expers. on, 220; Wiesner's exper. on, 220; hyrcanica, 160; sativa, 245.
Vilfa, 86.
Vinca rosea, 245.
Vincetoxicum parviflorum, var. alpina, 176.
Vines, solution for aleurone-grains, 242.
Viola Patrinii, 153.
Violarieæ (Afghan), 153.
Virgaria, 44.
Vitex Negundo, 182.
Vossia, 70.
Vossiæ, 69.
Vulpia, 127.

Wangenheimia, 106.
Ward, H. M., on Life-history of Hemileia vastatrix, 299.
Weingartneria, 95.
Wiesner, views of Ciesielski's exper. on veget., 219.
Windsoria, 110.
Withania somnifera, 180.

Xerochloa, 50.
Xystidium, 63.

Zea, 51, 53.
Zehneria umbellata, 141, 163
Zenkeria, 93; elegans, 93; obtusiflora, 93.
Zeobromus, 129.
Zeocriton, 133.
Zérán, vegetation valley of, 144.
Zeugites, 74, 121.
Zizania, 54; aquatica, 54; latifolia, 54; miliacea, 54; microstachys, 55.
Zizanieæ, 54.
Zizaniopsis, 54.
Zizyphus Nummularia, 155; oxyphylla, 156.
Zoysia, 63.
Zoysieæ (diagn.), 29, 32, 61.
Zygnema subtile, 231; Vaucherii, 231.
Zygnemaceæ, 231.
Zygophylleæ of Afghanistan, 155.

END OF THE NINETEENTH VOLUME.

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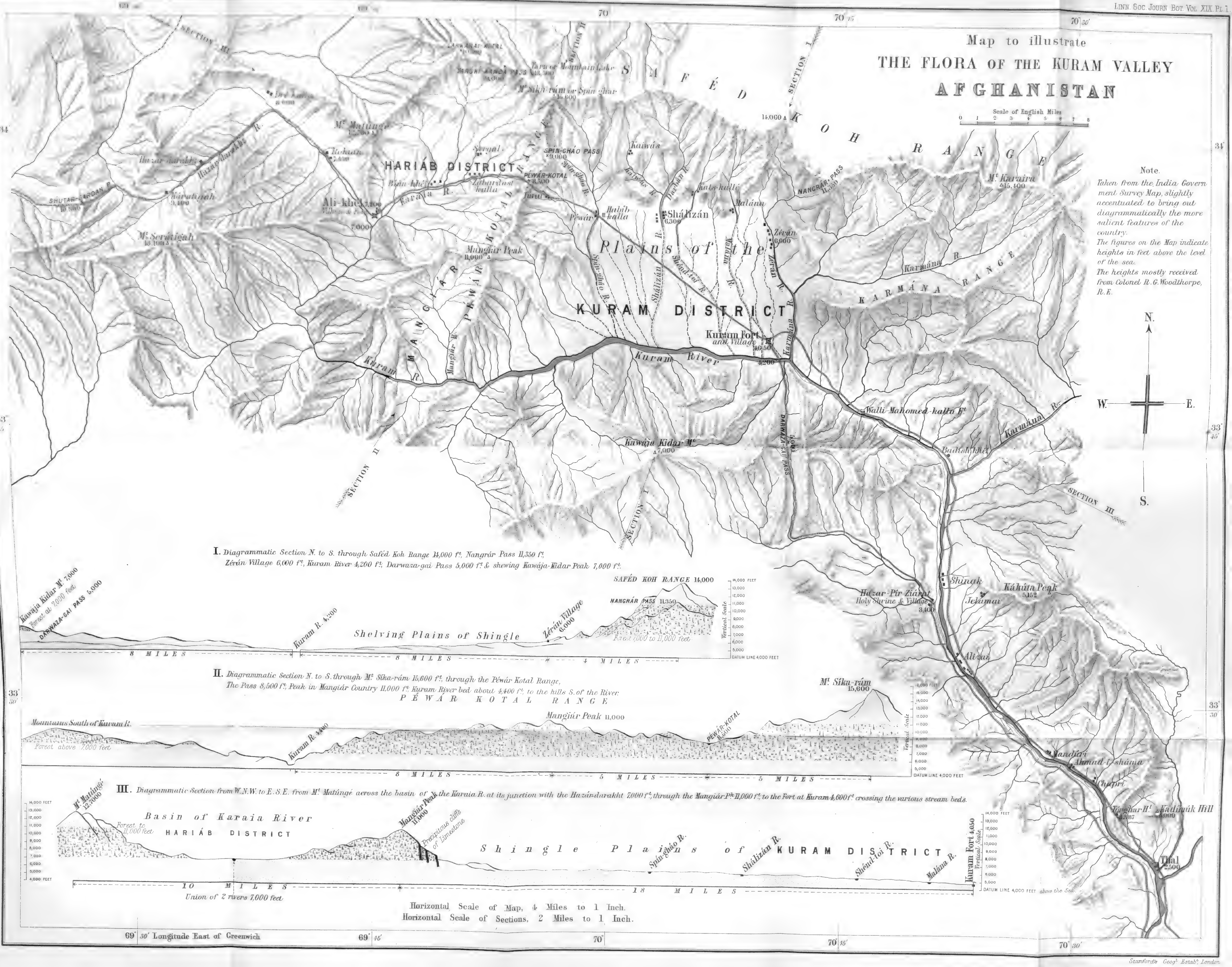
Map to illustrate
THE FLORA OF THE KURAM VALLEY
AFGHANISTAN
Scale of English Miles
Note.
Taken from the India Government Survey Map, slightly accentuated to bring out diagrammatically the more salient features of the country.
The figures on the Map indicate heights in feet above the level of the sea.
The heights mostly received from Colonel R. G. Woodthorpe, R.E.
SAFÉD KOH RANGE
HARIÁB DISTRICT
KURAM DISTRICT
Plains of the
Kuram River
Kuram Fort and Village
KARMÁNA RANGE
PÉWÁR KOTAL RANGE
MANGIÁR
SECTION I
SECTION II
SECTION III
Shingak
Alizai
Thal 2,500
Kádimúk Hill
I. Diagrammatic Section N. to S. through Saféd Koh Range 14,000 ft., Nangrár Pass 11,350 ft., Zérán Village 6,000 ft., Kuram River 4,200 ft., Darwaza-gai Pass 5,000 ft. & shewing Kawája-Kidar Peak 7,000 ft.
Shelving Plains of Shingle
II. Diagrammatic Section N. to S. through Mt. Síka-rám 15,600 ft., through the Péwár Kotal Range, The Pass 8,500 ft., Peak in Mangiár Country 11,000 ft., Kuram River bed about 4,400 ft. to the hills S. of the River.
PÉWÁR KOTAL RANGE
Mountains South of Kuram R.
Mangiár Peak 11,000
Forest above 7,000 feet
III. Diagrammatic Section from W.N.W. to E.S.E. from Mt. Matíngé across the basin of the Karaia R. at its junction with the Hazár-darakht 7,000 ft., through the Mangiár Pk. 11,000 ft. to the Fort at Kuram 4,600 ft. crossing the various stream beds.
Basin of Karaia River
HARIÁB DISTRICT
Shingle Plains of KURAM DISTRICT
Union of 2 rivers 7,000 feet
Horizontal Scale of Map, 4 Miles to 1 Inch.
Horizontal Scale of Sections, 2 Miles to 1 Inch.
69° 30′ Longitude East of Greenwich
Stanford's Geogl. Estabt., London.

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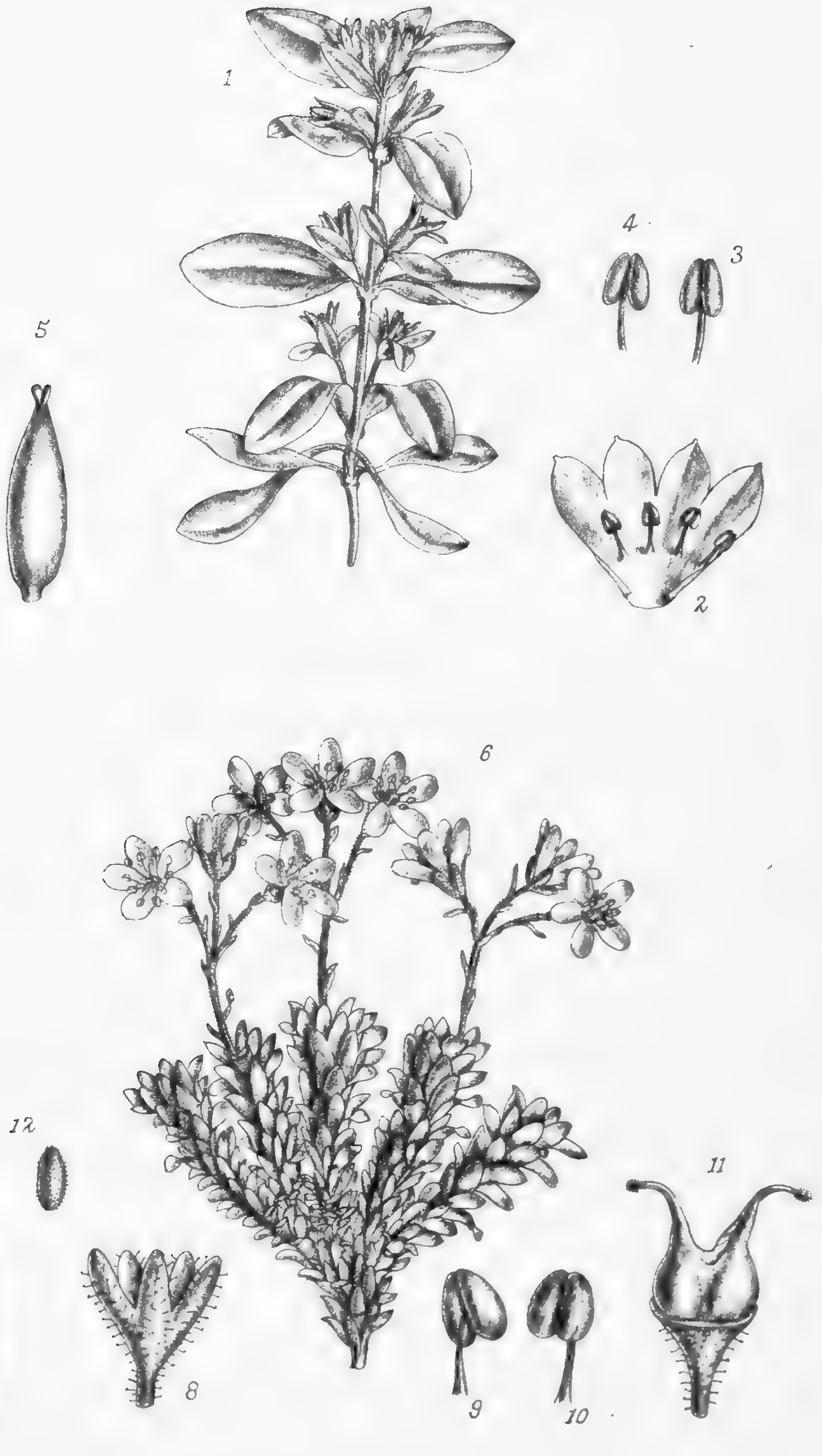

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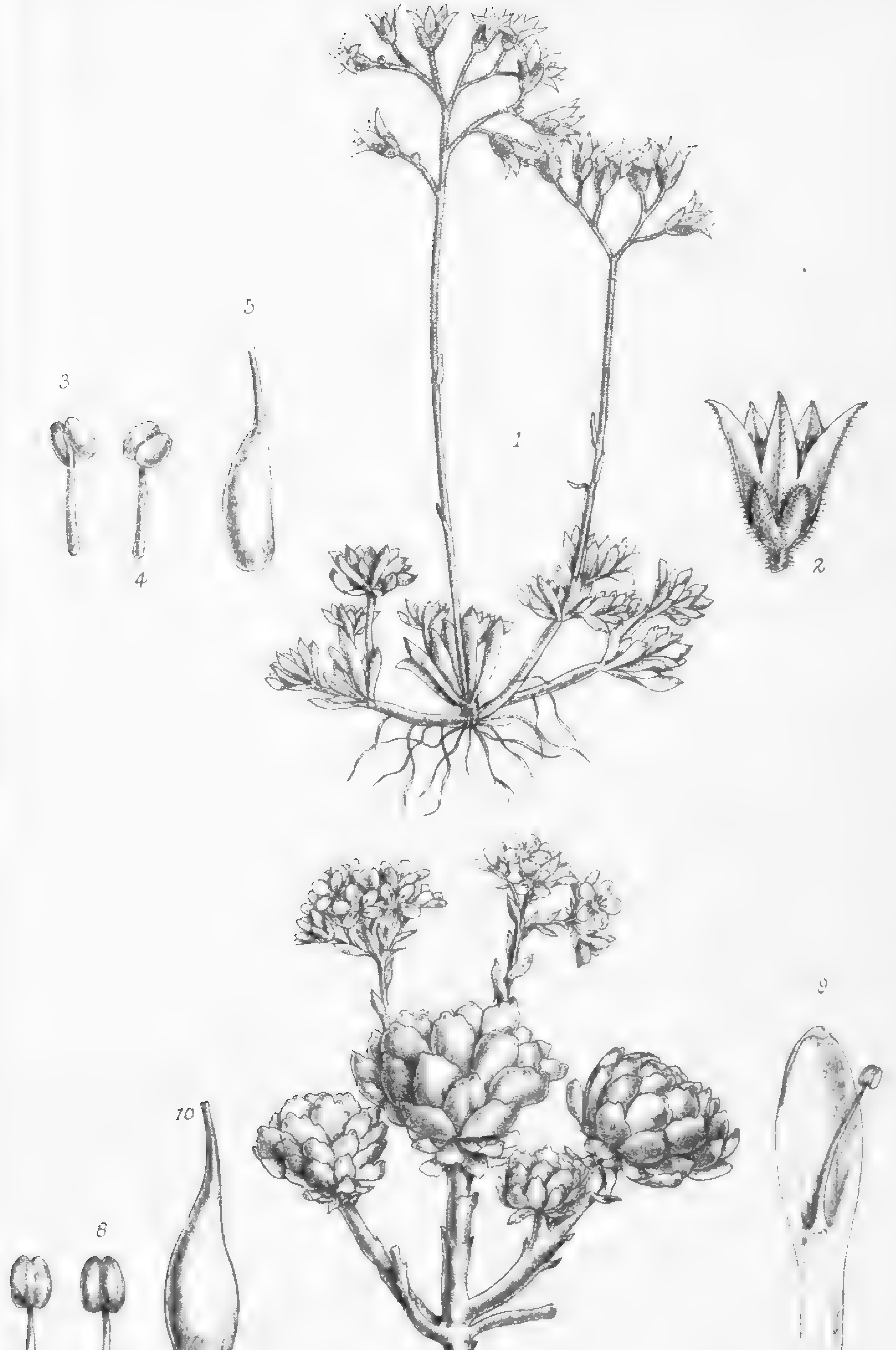

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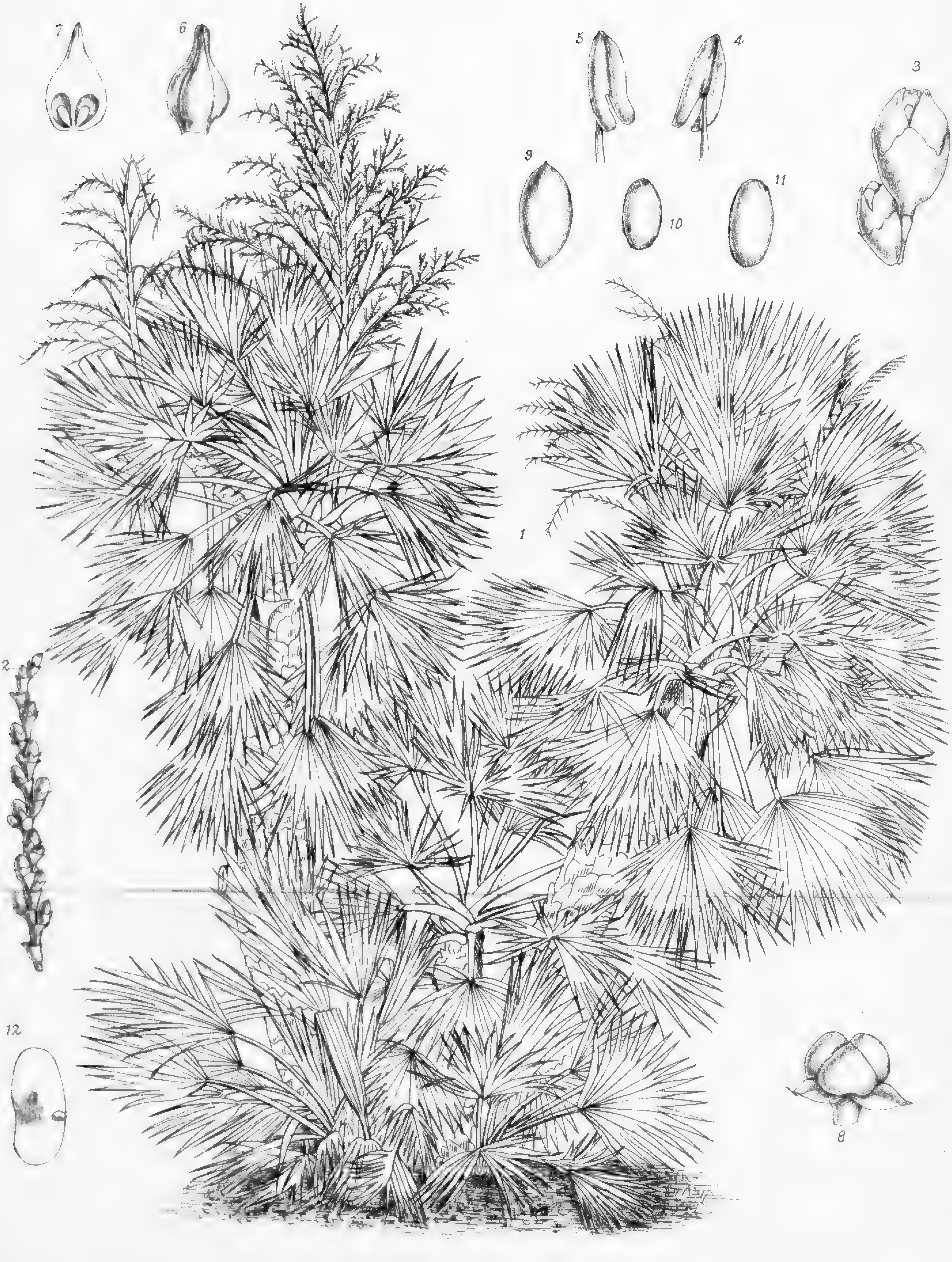

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PROLIFEROUS MIGNONETTE

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STAMINIFEROUS DIGITALIS PURPUREA.

N. Fitch lith. Fitch imp.

CORM REPRODUCTION OF CROCUS.

about one & a half times the actual size.

DISSECTION OF SPATHES OF CROCUS.
about half the actual size.